THE MARINE REVIEW

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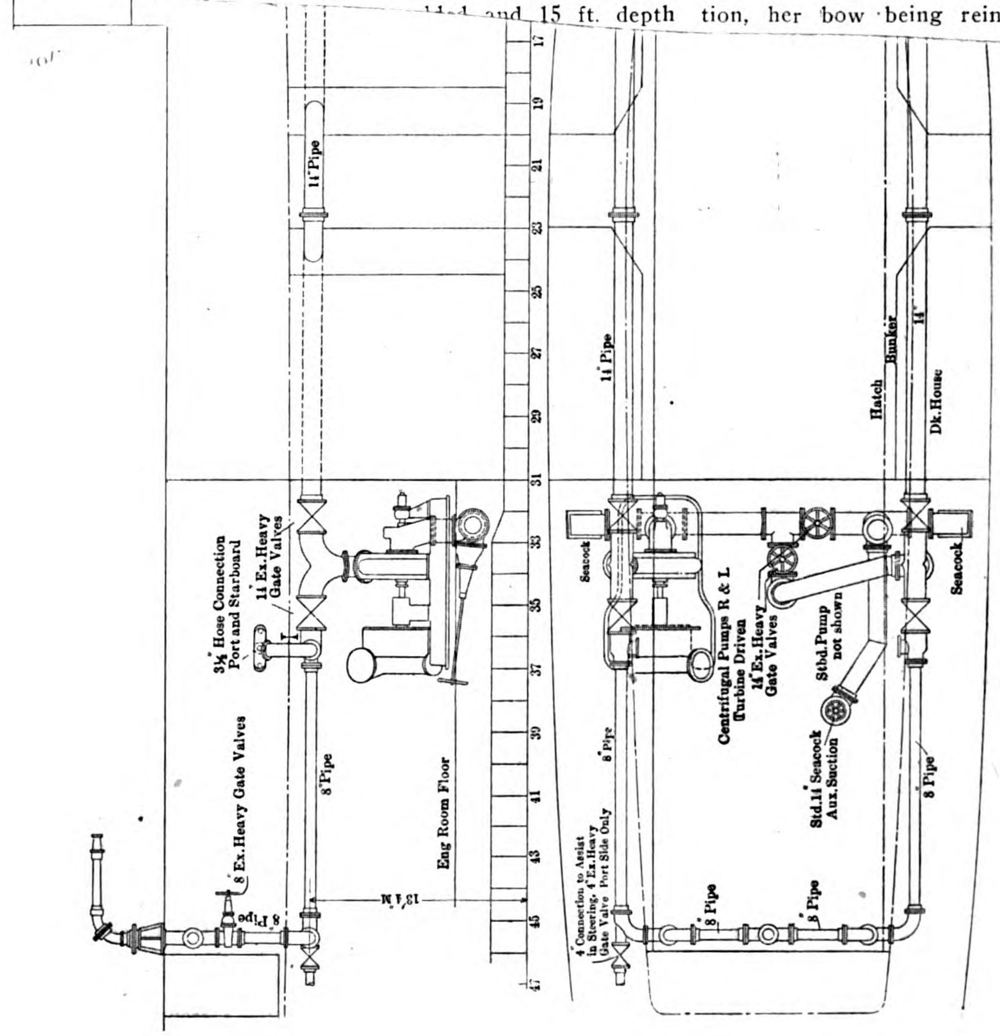
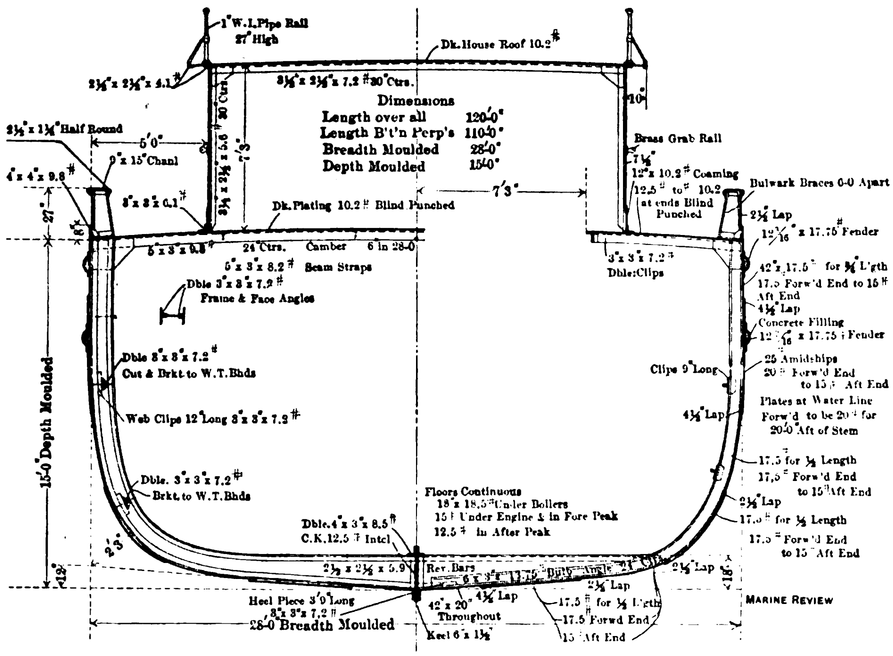
Fireboat W. A. McGonagle

THE FIREBOAT, W. A. McGonagle, built at the Lorain yard of the American Ship Building Co. for the Duluth, Messabi & Northern Railway, for the protection of the company's dock ... of Duluth, capacity of any fireboat in the world, is an interesting vessel. She has been specially designed to meet the hard conditions of the service and a number of unusual features are therefore embodied in her construction. The hull is 120 ft. over all, 110 ft. keel, ... and 15 ft. depth molded, divided into three watertight bulkheads with fore and aft peaks fitted for water ballast. She is built in excess of rules for this class of vessel owing to the severe conditions under which she will operate. She is of extra heavy construction, her bow being reinforced with



FIRE SERVICE PIPING, W.

of the doors are fitted with large size rollers to prevent chafing the hose during removal or stowing. The storeroom and lavatory are located in the after end of the deck house. The boat is equipped with a 16-ft. life boat, handled by a wrought iron



MIDSHIP SECTION, W. A. MCGONAGLE.

SCANTLINGS.

Frames; 6" x 3" x 13.75 lb. Bulb angles. Spaced 24" centers throughout. Ice frames forward between regular Frames, from center keelson to stringer. Made of 6" x 3" x 13.75 lb. bulb angle. Bhd. frame angles double 3" x 3" x 7.2 lb. Web frame angles double 3" x 3" x 7.2 lb. Web Frame Plate 12" x 15 lb. Web frame face angles, double 3" x 3" x 7.2 lb. Cant frames 4" x 3" x 8.5 lb.
Floors; continuous plate from bilge to bilge. 18" x 18.5 lb. in boiler space. 27" x 15 lb. in engine space. 15 lb. in fore peak. 12.5 lb. in after peak.
Beams; 5" x 3" x 9.8 lb. angles on every frame. Cant beams 4" x 3" x 8.5 lb.
Bulkhead; W. T. Bhds., 12.5 lb. plate. Vertical stiffeners, 3" x 3" x 7.2 lb., spaced 24". Horizontal stiffeners, 4" x 3" x 6.5 lb. spaced 48". Bunker Bhds. portable, 10.2 lb. plate, with 4" x 3" x 8.5 lb. angle stiffeners.
Center keelson; 12.5 lb. plate intcl. between floors. Riveted between double 4" x 3" x 8.5 lb. continuous angles.
Side Stringers; double 3" x 3" x 7.2 angles, cut at water tight bhds. and bracketed.
Keel; 6" x 1½". Stem; 7" x 2½"
Stern post, 7" x 3".
Rudder stock; 6" dia., pintle, 3½" dia.
Rudder plates, 10.2 lb.

RIVETING.

Rivets through keel, stem and stern post, ⅞" dia.
Shell rivets, ¾" dia.
Rivets through 12.5-lb. plate, ⅝" dia.
Rivets through 10.2-lb. plate, ½" dia.
Shell landings. Landing of "A" strake on "B" strake, and "G" strake on "E" and "H" strakes, to be 4½" wide and double riveted.
All other shell landings 2½" wide and single riveted.
Butts of shell plating to be double riveted and singly strapped; straps $\frac{1}{16}$" heavier than the plates they connect.
Deck plating to be flush.
Stringer butts to be double riveted and single strapped with straps 8" wide, and $\frac{1}{16}$" heavier than the plates they connect.
Seam straps 5" x 3" x 8.2 lb. angle.
Deck surfaces which are to be walked upon are to be blind punched.

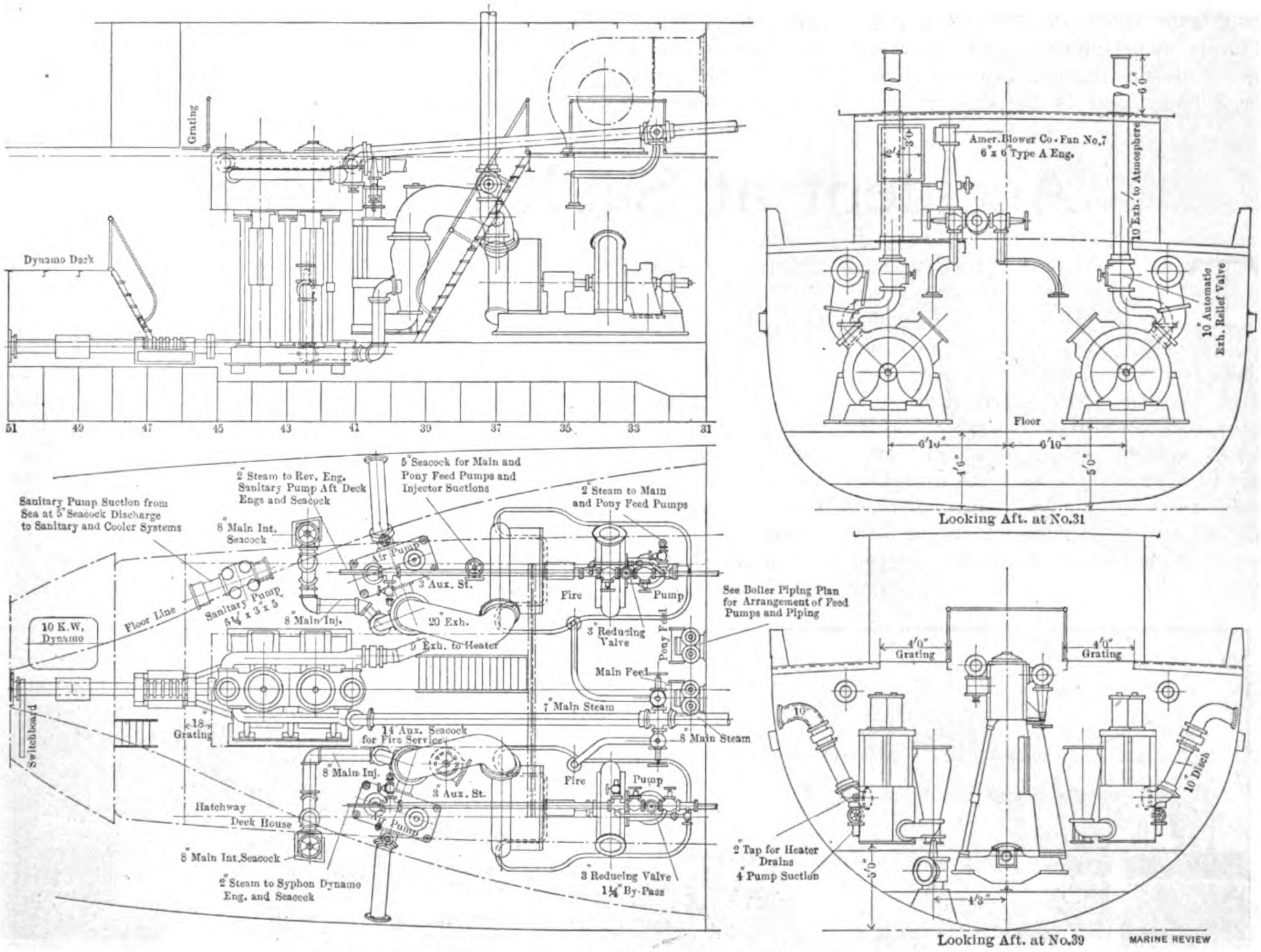
crane; also a life raft capable of sustaining the weight of 15 men.

Naturally in a vessel of this type the greatest interest centers in the machinery. The propelling engine is of the vertical, inverted, double-cylinder non-condensing type with cranks set at 90 degrees and with cylinders 20 in. diameter x 24 in. stroke, of especially heavy design for working under the full boiler pressure of 180 lb. and to meet the conditions imposed by winter work in heavy ice. The shaft is 8½ in. diameter and cranks are counter-balanced. The engine exhausts through a large feed heater and by means of switching valves the exhaust steam may be directed into either or both stacks or freely into the atmosphere through a separate escape pipe. The engine is fitted with steam and hand reverse gear and drives a cast steel, solid, four-bladed, propeller, 8 ft. 6 in. diameter and 10 ft. pitch with an expanded area of 34 sq. ft.

The fire pumps consist of two horizontal Curtis steam turbines, supplied by the General Electric Co. and directly connected to two-stage centrifugal pumps. Each pump has a capacity of 6,000 gallons of water per minute, or a total capacity of 12,000 gallons per minute against a pressure of 150 lb. per sq. in. when operating at a speed of 1,800 revolutions per minute. To put it in other words, the pumps are capable of throwing 50 tons of water per minute against a head of 350 ft. The turbines work under the full boiler pressure of 180 lb., and each exhausts into an independent Blake jet condenser of the vertical type, guaranteed to maintain a vacuum of 27 in. under full load. An automatic free atmospheric exhaust is also provided in event of the vacuum failing from any cause.

The pumps are so arranged that they may be worked in series, under which arrangement their capacity is 6,000 gallons per minute against a pressure of 300 lb. per sq. in. When so connected the starboard pump takes suction direct from the sea, discharging at 150 lb. pressure into the suction of the port pump, which, in turn, delivers into the fire mains at 300 lb. pressure. It is stated that the stream thus thrown is strong enough to cut out a section of the dock, if it should be necessary to destroy it to prevent the spread of fire. There are three monitors, one on the deck forward of the pilot house, one on top of the pilot house and one on top of the deck house aft. Each of these are fitted with nozzles ranging from 3 in. diameter to 5 in. diameter. In addition to this there are six 3½-in. hose connections, placed forward of the pilot house and three similar connections on each side of the deck house amidship. The fire mains run from 14-in. to 8-in. diameter and are all extra heavy with maled and femaled joints and tested for the maximum working pressure of 300 lb.

Steam is supplied by two Scotch boilers 13 ft. 9 in. diameter by 11 ft. 6 in. long, allowed 180 lbs. pressure. Each boiler contains two Morrison furnaces 50 in. mean diameter, fitted with separate combustion chambers and 348 3-in. tubes 8 ft. 2 in. long. The boilers are fitted with forced draft on the closed stokehold system, the air being supplied by an American Blower Co. fan with direct-connected engine placed on deck in the engine room. Feed water is supplied to the boilers by two vertical duplex pumps, either of which has ample capacity to feed the boilers when steaming at full power. Two ash ejectors are fitted in the stokehold for discharging the ashes overboard. Smoke-box doors are fitted with the Silley patent fasteners, as is now the standard practice of the American Ship Building Co.

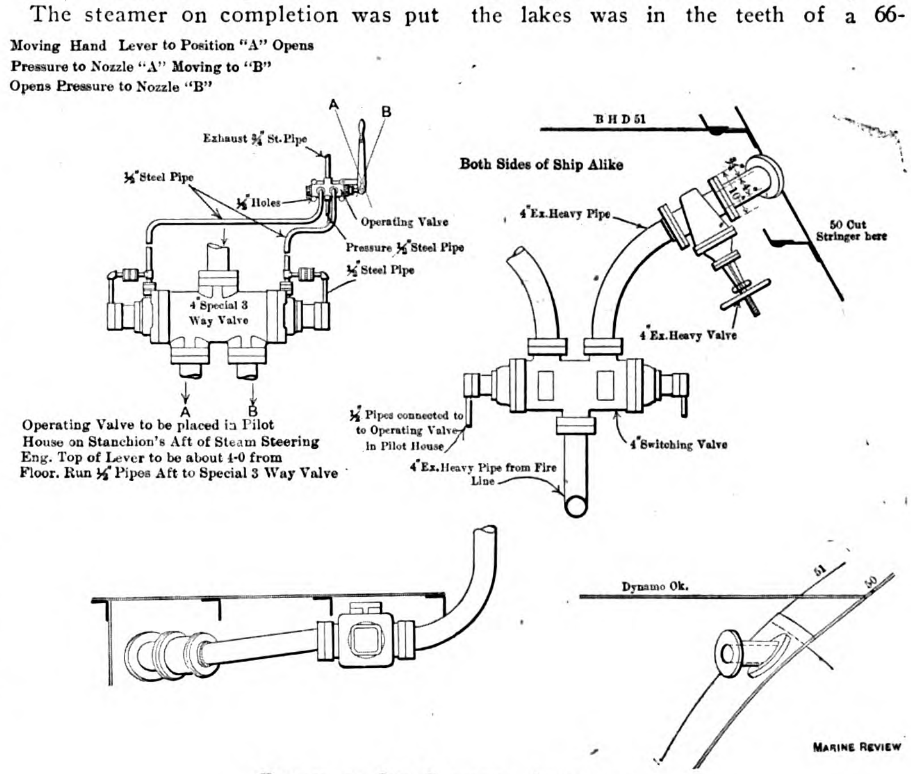


General Arrangement in Engine Room, W. A. McGonagle.

On trial these boilers supplied steam to the fire pumps at their full capacity without any effort.

The steering apparatus consists of a combined hydraulic and hand pilot house gear, supplied by the Queen City Engineering Works, Buffalo, N. Y. In addition to this, for the purpose of maneuvering the boat at a fire when without headway, a jet steering apparatus is fitted consisting of a special hydraulic valve fitted near the stern and operated by hydraulic connection from the pilot house. By this apparatus a 4-in. stream of water under the same pressure as the fire main, can be discharged from either side 4 or 5 ft. below the water line, the effect being to swing the boat o.. her own axis. This apparatus can also be used when the steamer is under way to assist the ordinary gear in swinging her quickly around sharp turns. She will have to maneuver in extremely limited spaces, as it is the intention to construct tunnels through the ore docks in order to avoid the necessity of going entirely around the end of the dock in order to reach the other slip. It is expected that this jet steering apparatus will enable her to make these sharp turns in quicker time than would otherwise be possible.

The steamer on completion was put through an exhaustive series of trials both as a sea-going craft and as a fire fighting machine. Her first trip on the lakes was in the teeth of a 66-



Detail of Jet Steering Apparatus.

mile gale when she left Lorain for Cleveland, in spite of which, however, she made the run between these ports in 2 hours and 14 minutes, the distance being approximately 30 miles, the engines averaging about 140 R. P. M. On her arrival at Cleveland her fire pumps were tested in the harbor in the presence of representatives from the fire department and the guaranteed capacity and pressure were easily attained.

Accident at Sault Ste. Marie

THE MARINE REVIEW had occasion recently to note that in the 54 years of operation of the canals at the Soo, there has never been a serious accident. We have now to chronicle probably the most serious disaster which could possibly happen to a lock canal, and the results are such as to inspire only renewed confidence in the practically certain freedom from accident in canal operation. When we consider the number of lockages that have taken place at the Soo, the fact that similar accidents are not more frequent is simply marvelous. The three locks in the canal at the Sault Ste. Marie are of the following dimensions: The oldest, known as the Weitzel lock, on the American side, opened in 1881, is 515 ft. between gates, 80 ft. wide in the chamber and 60 ft. wide at the gates. The Poe lock, opened in 1896, is 800 ft. long, 100 ft. wide in the chamber and 80 ft. wide at the gates. The Canadian lock is 900 ft. long and 60 ft. wide through gates and chamber.

An idea of the work done in the operation of these canals may be gathered from the fact that the canal records show that the Poe lock has locked 93 vessels in one day with 36 lockages; and the Canadian lock has locked 56 vessels in one day with 34 lockages.

The accident occurred about noon on Wednesday, June 9. The Assiniboia, a Canadian Pacific Ry. passenger steamer, had entered the Canadian lock bound down and made fast, her position, of course, being close to the lower gates. The Pittsburg Steamship Co.'s steamer Crescent City, a bulk freighter, carrying about 7,000 tons of iron ore, was entering the lock and had not entirely cleared the upper gates which were thus necessarily open. The steamers are respectively 346 ft. x 43 ft. and 426 ft. x 48 ft., the displacement of the Crescent City being probably nearly double that of the Assiniboia. The mean difference of level between upper and lower approaches on the day of the accident was 19.5 ft. The Gilchrist Transportation Co.'s steamer Perry G. Walker, 436 ft. x 51 ft., bound up, loaded with coal, was approaching the lock from below but had not yet made fast below the lock as customary. Either through some error of judgment as to speed on the part of her master, or some misunderstanding of engine signals, she was driven into the south gate of the lock at an estimated speed of between five and six miles per hour. The forcing inward of one gate even slightly, removed from the other the support afforded by the mitered ends, and the head of water behind it immediately carried it down stream, followed, of course, immediately by the other. It is not at all probable that the gates were damaged to any extent

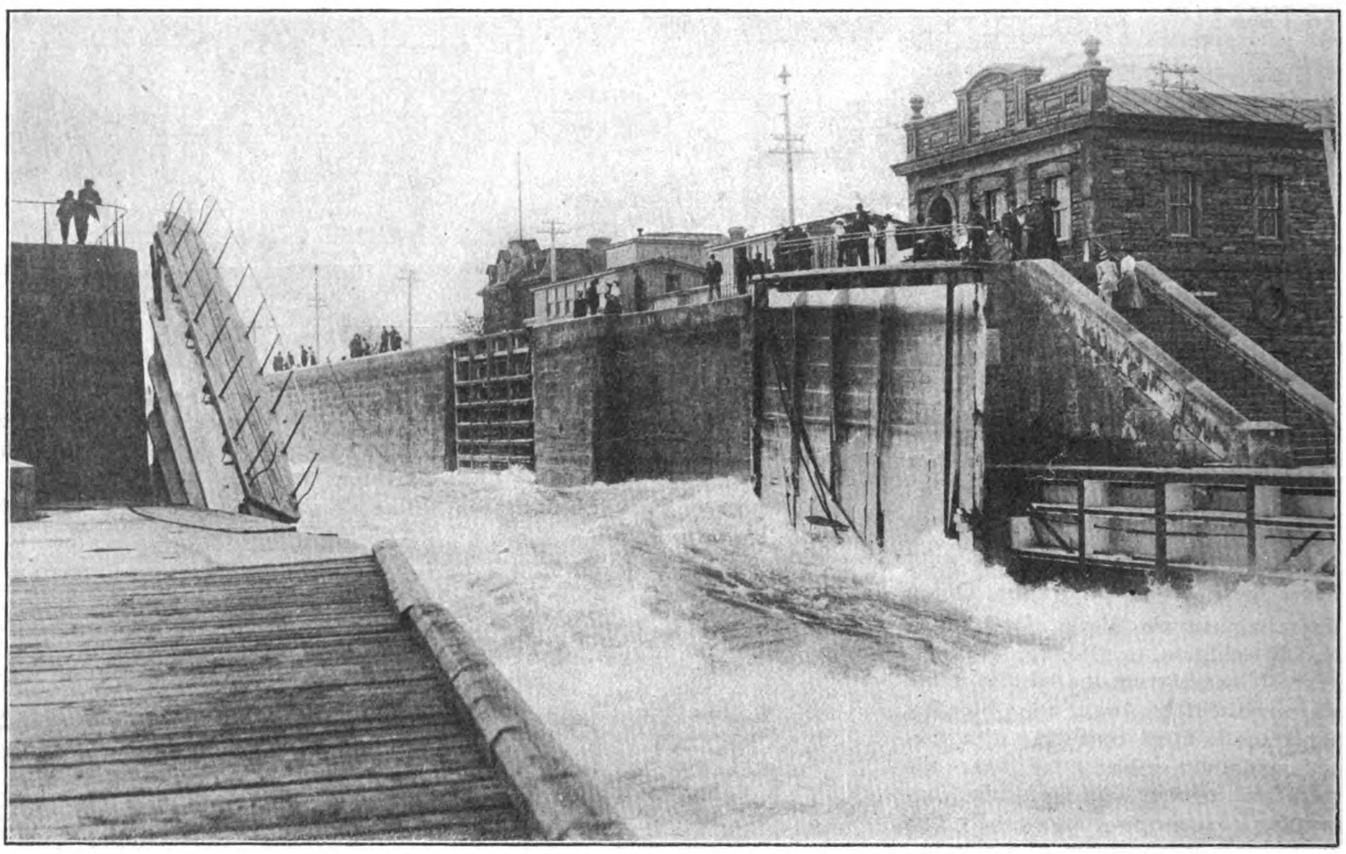


FIG. 1.—VIEW FROM LOWER END OF LOCK, TAKEN ABOUT FIFTEEN MINUTES AFTER THE ACCIDENT.

Photos copyrighted 1909 by Young, Lord & Rhoades.

FIG. 2.—VIEW AT UPPER END OF LOCK, TAKEN AT SAME TIME AS FIG. 1, LOOKING UP STREAM. SHOWS TOTAL DISAPPEARANCE OF UPPER GATES.

by the impact in itself, and the photographs show such was actually the case. The resulting rush of water immediately carried the Walker back along the south wall of the lower approach. The Assiniboia, of course, dropped with the water in the lock, snapping her mooring lines and then, carried out of the lock with the rush of water, striking the Walker on the starboard side, forcing the latter around parallel with the south canal bank. The captain of the Assiniboia then let go an anchor which, however, proved to be unfortunate, as will be seen. The Crescent City at this instant, as has been said, was just entering the lock chamber and was consequently

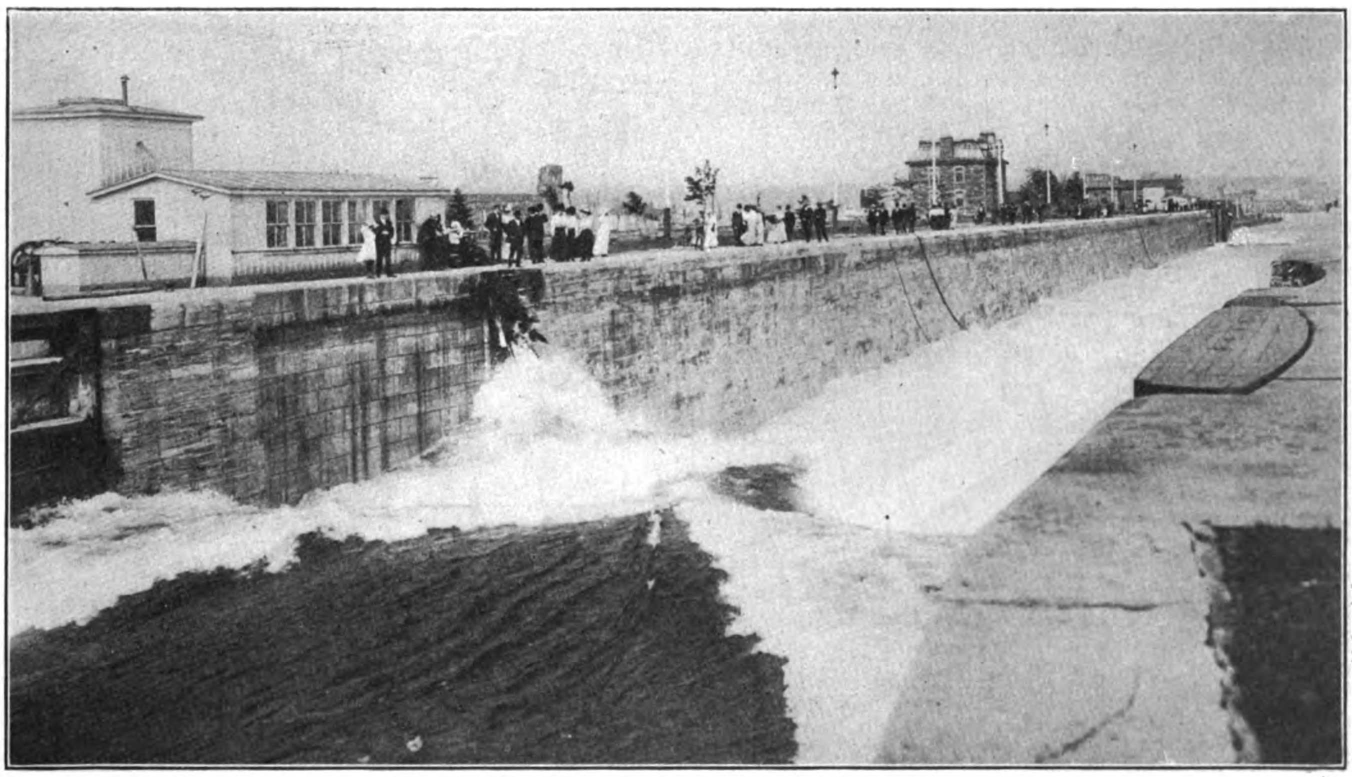


FIG. 3.—VIEW AT UPPER END OF LOCK LOOKING DOWN STREAM, TAKEN SAME TIME AS FIG. 2.

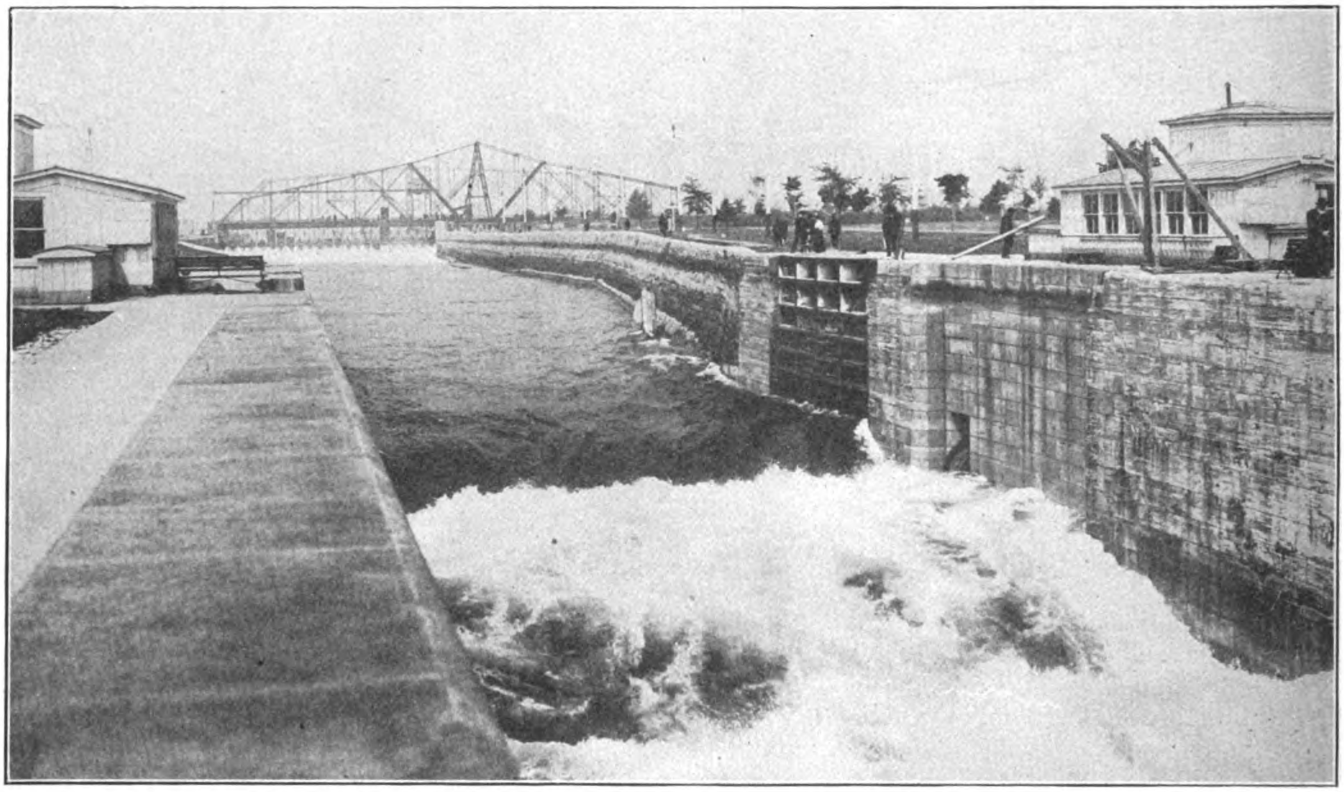


FIG. 4.—VIEW FROM ABOUT THE SAME POINT AS FIG. 2, LOOKING UP STREAM TOWARDS MOVABLE DAM, WHICH HAS BEEN SWUNG INTO POSITION. SHOWS CHECKING OF FLOW OF WATER.

immediately over the upper sill. The water dropping out of the chamber lowered her bow so that the current rushing in through the restricted passage along her sides washed over her forward deck; but gathering headway rapidly, she shot over the sill and settling into the lock chamber, submerged, momentarily, her after deck and was then shot through the chamber and down stream where she fouled the Assiniboia, the latter's stem cutting a serious gash in the Crescent City's port bow. Both the Walker and Assiniboia took the ground and the Crescent City crossed to the American side. The two former were easily released, and the Assiniboia proceeded down the

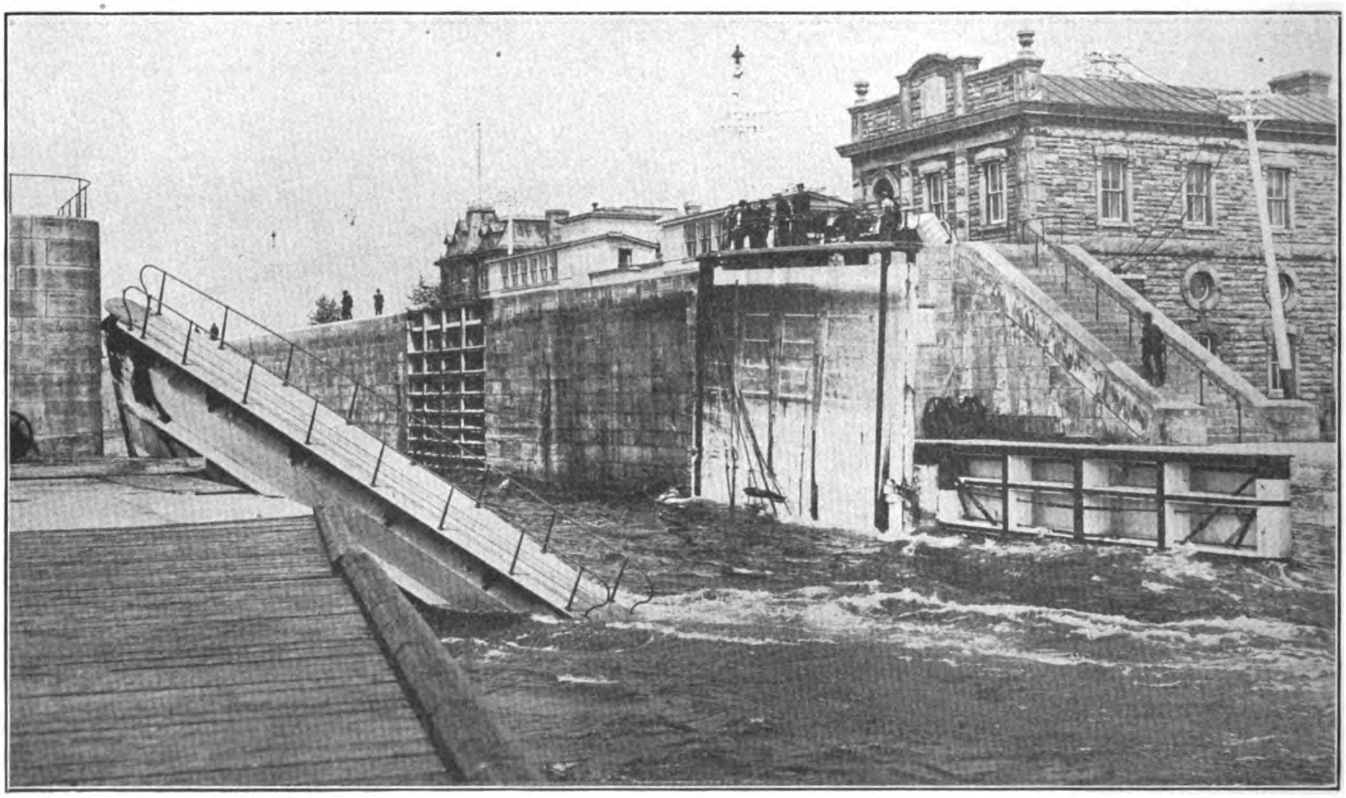


FIG. 5.—VIEW TAKEN THE FOLLOWING DAY. SHOWS SOUTH GATE FALLEN DOWN; AND THE EFFECT OF THE DAM.

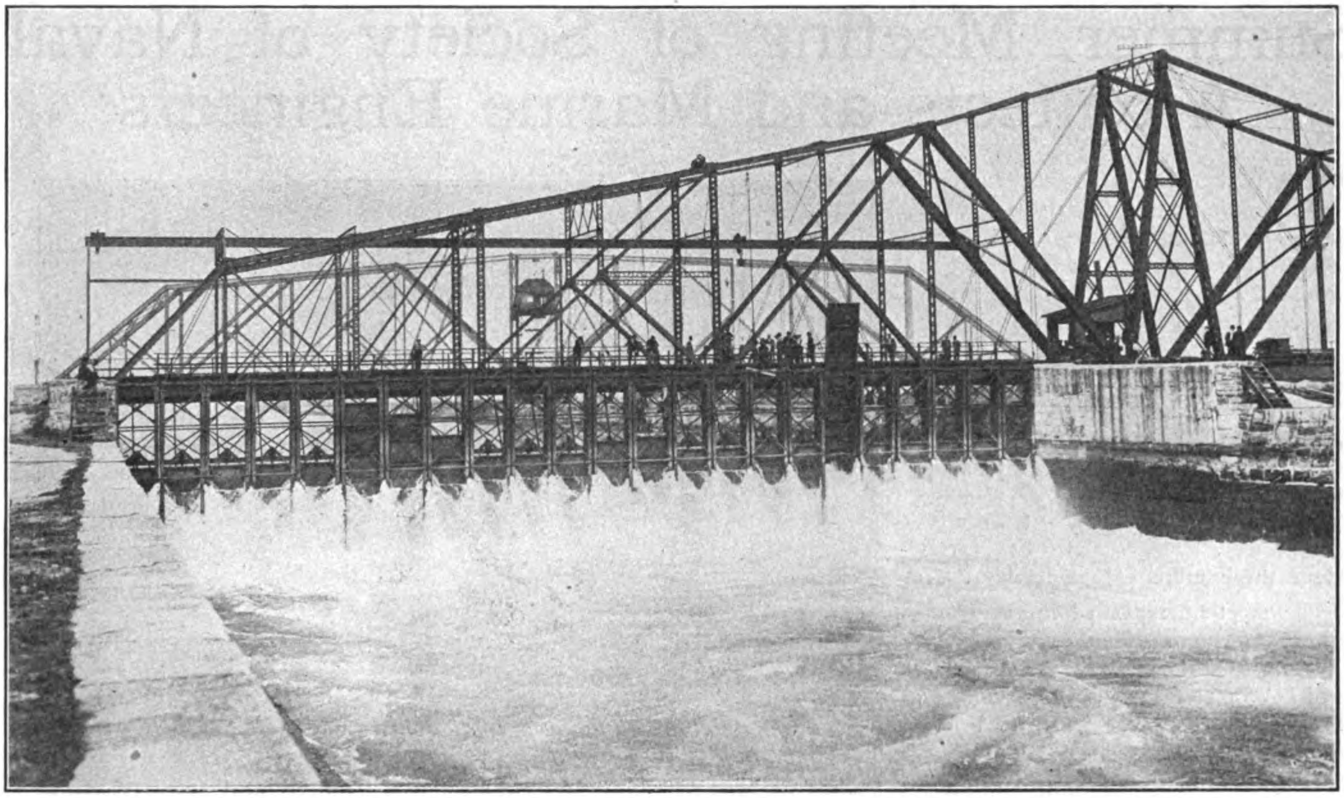


FIG. 6.—CLOSE VIEW OF MOVABLE DAM WITH ALL BUT FOUR WICKETS IN POSITION.

river after lightering part of her cargo, and then proceeded to her destination at Owen Sound. The Walker and Crescent City were given temporary repairs so that after a few days they were able to proceed. All three have since been dry-docked; the Assiniboia at Collingwood, the Walker at Superior and the Crescent City at Toledo. The Assiniboia had 24 damaged plates, of which 17 were rerolled and put back and seven faired in place, and a number of frames were also straightened.

The Crescent City is reported to be one of the worst cases of damage ever occuring the lakes, and will have to be given an almost entirely new bottom and floors. That she did not actually break in, two in passing over the upper sill, is nothing short of marvelous. Probably a large part of her bottom damage was occasioned thereby and was completed by her downward rush into the shoal water at the foot of the canal.

The Walker's damages are reported to consist of shoe and rudder and slight damage forward.

The rush of water through the lock tore adrift the upper main gates which, as before noted, had not yet been closed, thus leaving open an unobstructed channel from Lake Superior.

The photographs herewith tell, graphically, the story from the time the chamber emptied itself. Fig. 1, taken about 15 minutes after the accident, from the lower end of lock, shows the demolished gates still hanging to the masonry. The lower guard gates, used only when the chamber is to be dried out, can also be seen. This view also shows one of the inner pair of lower gates which are used only in case of damage to the outer or main gates as in this case, and which are intact so that so far as the lower end is concerned, locking could still be proceeded with.

Fig. 2 is a view taken at the same time as Fig. 1 near the upper end of the lock, looking west, and shows the total disappearance of the main gates.

Fig. 3 is a view taken from above the lock chamber, looking east. The lines seen hanging over the lock wall are those of the steamers which were in the lock and which were snapped off like thread. In this and in Fig. 2 the break of the current over the upper sill is plainly evident. Another pair of gates are also visible, but these are not available for locking because of the fact that the filling culvert is located between the two sets of upper gates.

Fig. 4 shows the movable dam above the lock swung into position and the flow of water falling off. The dam is seen in Fig. 2 in its normal position.

Fig. 5 from the lower end of lock shows the south gate fallen down and comparison with Fig. 1 shows the effect of the dam in reducing the flow of water.

Figs. 4 and 5 were taken the day following the accident.

Fig. 6 is a near view of the dam and shows its construction. It is practically a swing bridge, one arm carrying the wickets in which slide the closing-off gates and which when not in use, are folded up under the floor of the bridge; the other arm is merely a counterweight.

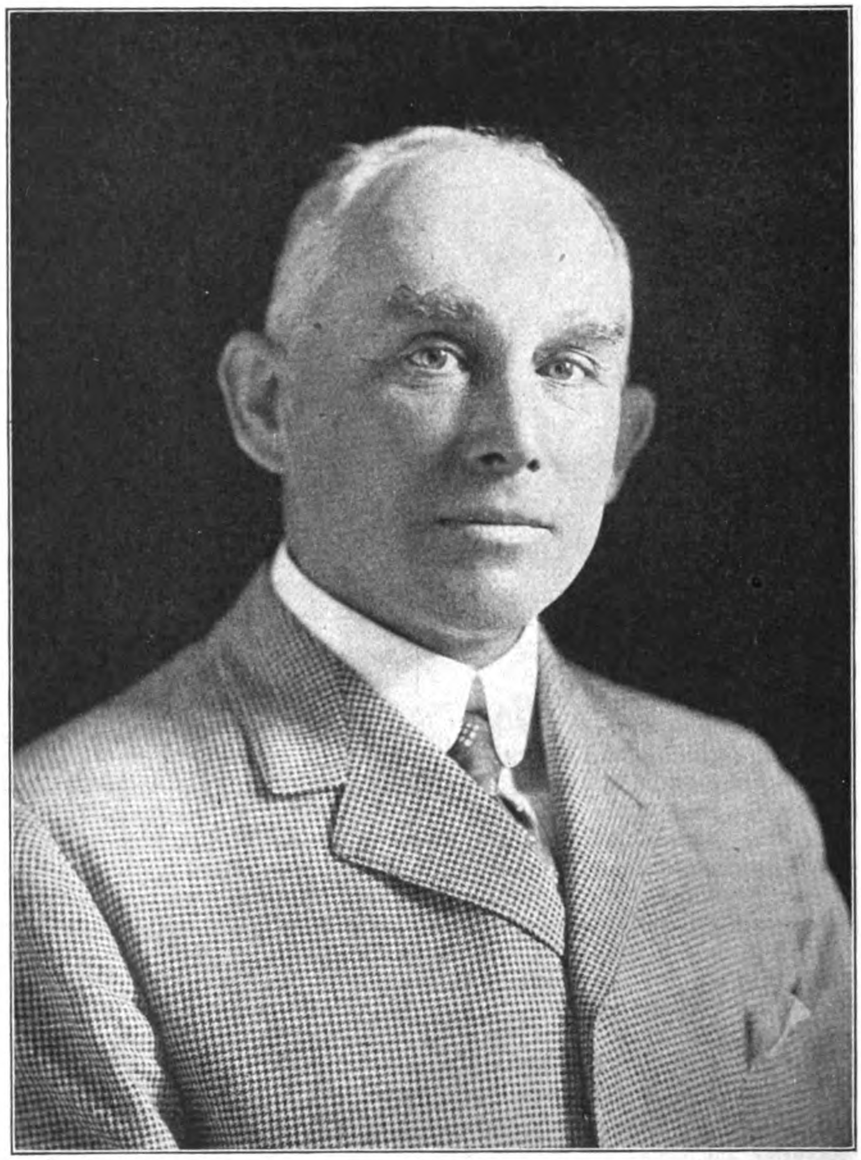
The fact that some of the wickets fouled an obstruction in the bottom of the canal, making their operation impossible, somewhat delayed the complete closing off of the flow of water, and alternative methods had to be adopted; but by the morning of June 13 these efforts had been so far successful that it became possible to close the gates, and the lock has since been repaired and was replaced in commission on June 21. The lock walls are not damaged nor any of the operating machinery, and the total cost of repairs will not be heavy.

After all, the chief feature of the entire accident is the demonstration of the possibility of controlling lock canals even in case of the carrying away of gates and is not without value in connection with the Panama Canal.

Summer Meeting of Society of Naval Architects and Marine Engineers

THE FIRST summer convention of the Society of Naval Architects and Marine Engineers, which was held in Detroit on June 24, 25 and 26, was a success in every way even though the attendance from the east was disappointingly small. However, the enthusiasm of those who were present made up in great degree for the small attendance and probably assures as well the establishment of summer meetings as a permanent feature of the society. The society has rarely spent three more enjoyable days.

The meeting convened in the council chamber on Thursday morning, the address of welcome being delivered by the controller of the city, to which Mr. Frank E. Kirby briefly responded, in the absence of President F. T. Bowles, whose train was late. The session immediately adjourned to attend the launching of the package freighter Conemaugh, building at the Wyandotte yard of the American Ship Building Co. for the Anchor Line. Side launching into slips not much bigger than the ships themselves are always of interest to coast ship builders. The society witnessed the launching from the deck of the excursion steamer Britannia, which had been chartered for the day. The steamer then proceeded down the river to afford the visitors an opportunity to inspect the new Livingstone channel at the mouth of the Detroit river, luncheon being served while enroute. Brief speeches were made by President Bowles, President Livingstone of the Lake Carriers' Association, Commander W. P. White of the Wolverine, Mr. J. C. Evans of the Anchor Line, and Mr. John R. Russel of the Great Lakes Engineering Works.



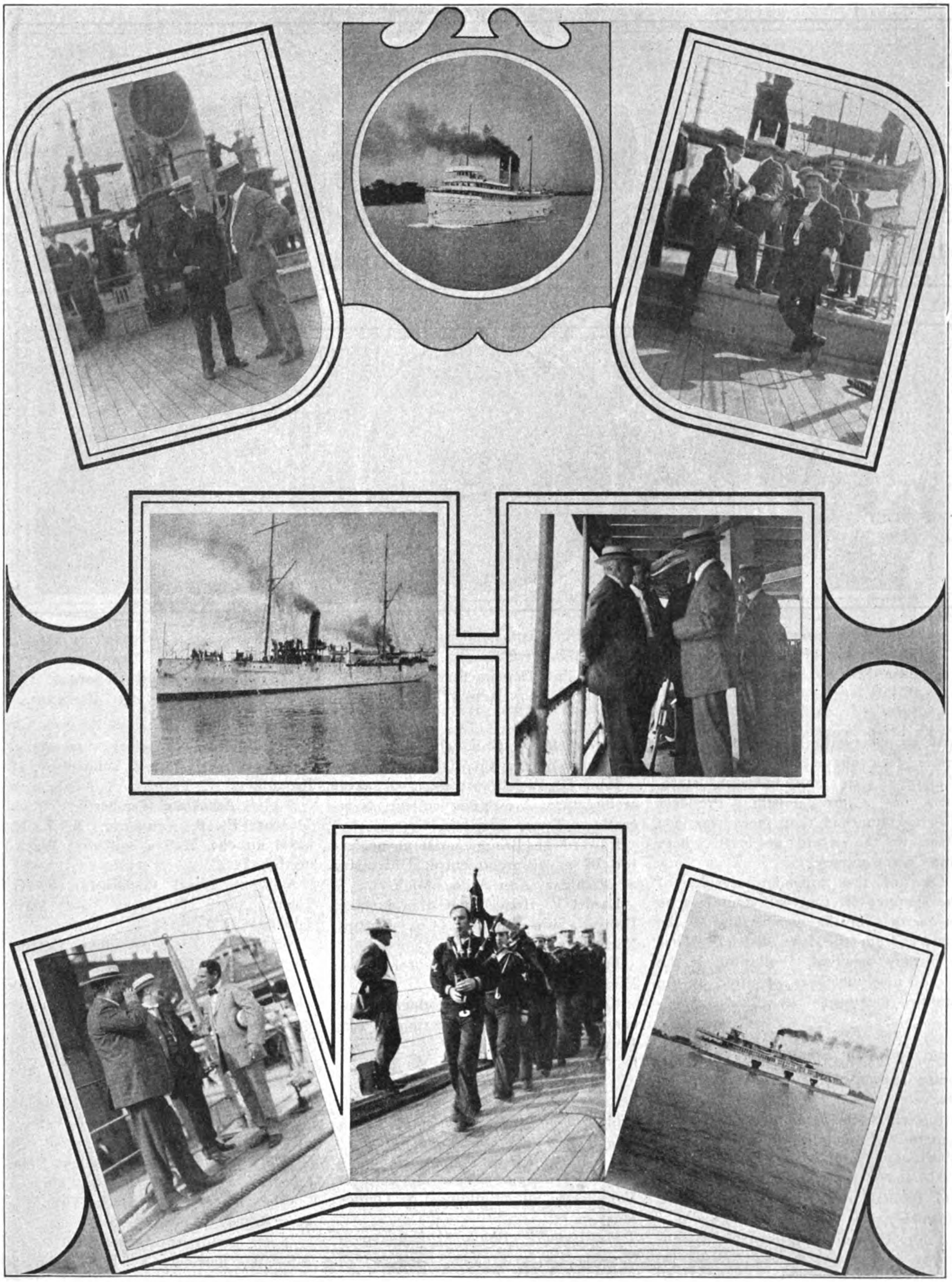
PRESIDENT FRANCIS T. BOWLES.

President Bowles, in referring to the rapidity of construction of the Conemaugh, said that it was due to organization and that the achievements of lake ship builders were the pride of American ship building. He also considered it gratifying that a channel was being constructed on the lakes for ships carrying the American flag.

It was noted that in President Livingstone's remarks the expressions which aroused the greatest interest were those which dwelt with facts. For instance when he stated that over 10,000 gross tons of ore had been put aboard the Corey at Ashland last month in 63 minutes their attention became instantly concentrated. It so happened that the steamer J. Q. Riddle went by, 545 ft. in length, and when it was stated to the members that only 45 days had elapsed from the laying of her keel until she went out under her own steam with 10,000 tons of coal aboard they were powerfully impressed. It was a concrete illustration of lake capacity.

The new Livingstone channel which is being dredged in the dry was an object of especial attention to the members. This system of dredging, first tried on West Neebish, works out at one-half the cost of dredging in the wet. It is expected that it will be ready for navigation next year. It was just one of those strange coincidences in life that as the members were inspecting the Livingstone channel the steamer William Livingstone passed by.

On the return trip the plant of the Great Lakes Engineering Works at Ecorse was visited. The bulk freighter Shenango was undergoing her finishing touches and the members took great pleasure in thoroughly inspecting her. Especially were they amazed at the elaborate provision made for the entertainment of guests, there being not only a private dining room aft but a grill room with tile flooring and brick fireplace forward, connecting

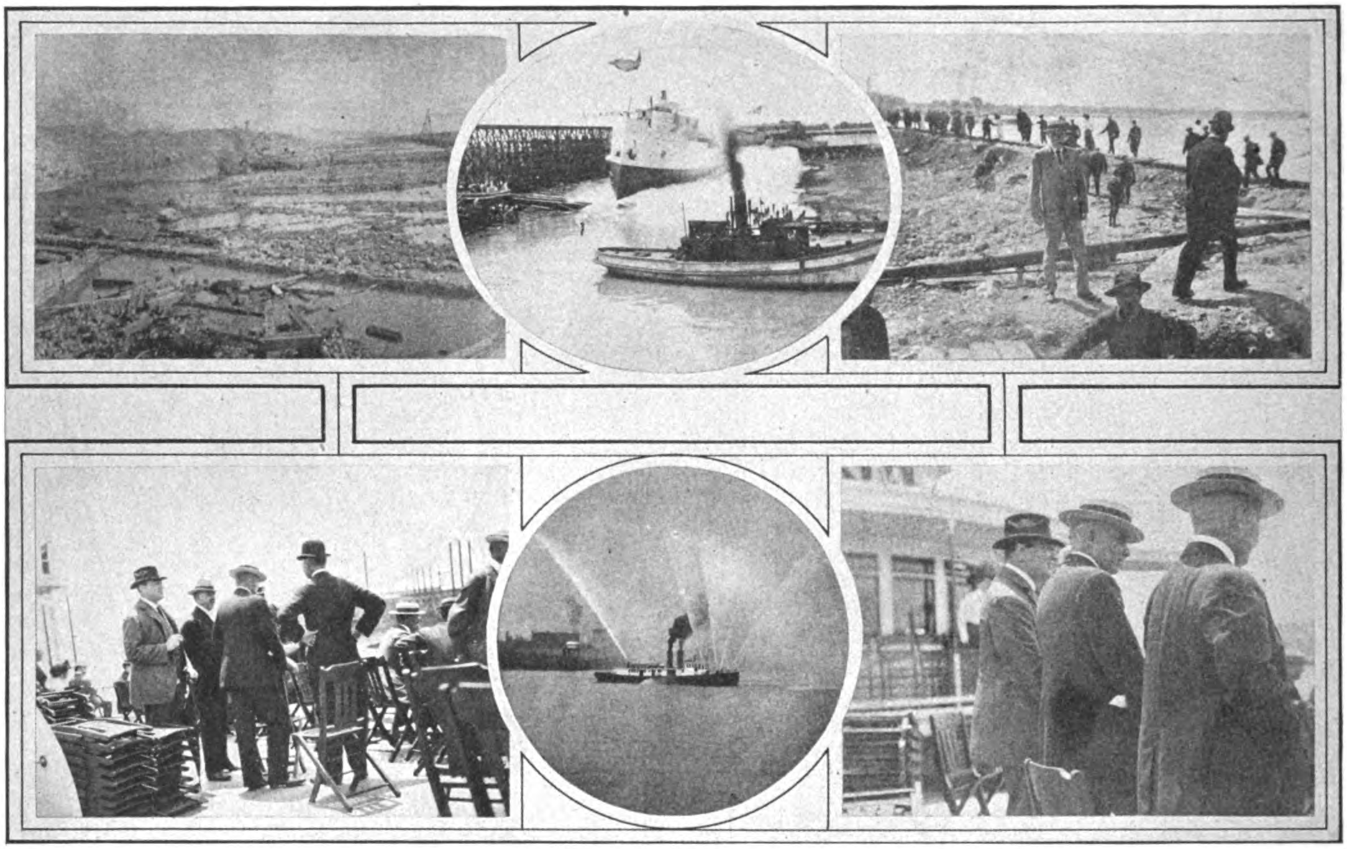


HARVEY D. GOULDER AND CAPT. GEORGE A. WHITE ON THE SAN JUAN DE AUSTRIA.
THE SAN JUAN DE AUSTRIA.
MR. E. S. WRIGHT AND ROBERT LOGAN.

THE NORTH LAND.

JAMES E. DAVIDSON REVIEWING THE NAVAL RESERVES.

O. T. WARREN, J. M. SMITH, A. G. SMITH AND T. S. KEMBLE.
STEVENSON TAYLOR, W. I. BABCOCK, H. D. GOULDER AND H. C. SADLER.
THE WAUKETA, BUILT IN NINETEEN DAYS.



THE LIVINGSTONE CHANNEL.
J. A. UBSDELL, H. W. HOYT AND ADMIRAL BOWLES ON THE BRITANNIA.

LAUNCHING THE CONEMAUGH.
THE DETROIT FIRE TUG IN ACTION.

PRESIDENT LIVINGSTONE ON THE LIVINGSTONE CHANNEL.
J. A. UBSDELL, ADMIRAL BOWLES AND GEORGE H. GUY ON THE BRITANNIA.

with an observation room on the forecastle deck above containing an orchestrelle. In addition each stateroom has a private bath. President Bowles remarked that there was one place in the world at least where ships made money.

One of the immediate results of the summer meeting will doubtless be an increase in the membership of the society from the lake district. That is already apparent. Following is the list of new members admitted at the summer meeting:

For Member.

Bert C. Ball, chief engineer, Willamette Iron & Steel Works, Portland, Ore.

Russell B. Bedford, engineer, marine department, American Blower Co., 141 Broadway, N. Y.

Alexander E. Brown, vice president and general manager Brown Hoisting Machinery Co., Cleveland, O.

John G. Johnson, consulting engineer and marine superintendent, Jacobs & Davies, 30 Church street, N. Y.

Archibald P. Rankin, chief engineer American Ship Buildng Co., Cleveland, O.

Frederick R. Still, chief engineer, American Blower Co., Detroit, Mich.

John G. Welch, professor of naval architecture, Armstrong college, Newcastle-on-Tyne, England.

Edward M. Bragg, assistant professor of naval architecture, University of Michigan, Ann Arbor, Mich.

Daniel E. Hoag, chief draughtsman, Detroit Ship Building Co., Detroit, Mich.

Frederick Metcalf, treasurer Chase Machine Co., Cleveland, O.

George A. Mattsson, chief engineer, Great Lakes Engineering Works, Detroit, Mich.

Associate to Member.

Assistant Naval Constructor J. R. Bailey, U. S. N. navy yard, Pensacola, Fla.

Junior to Member.

John J. Crain, electrical engineer, Fore River Ship Building Co., Quincy, Mass.

Matthews E. Davis, 51 Lake street, Saranac Lake, N. Y.

Harold M. DeGraw, hull draughtsman, New York Ship Building Co., Camden, N. J.

Daniel M. Luehrs, chief engineer, McCreery Engineering Co., Toledo, O.

Daniel I. Whittelsey, secretary-treasurer, Whittelsey & Whittelsey, 11 Broadway, N. Y.

Associate Member.

Lieut. E. P. Camperio, R. I. N. naval attache, Italian embassy, Washington, D. C.

Assistant Naval Constructor E. G. Coburn, U. S. N., Navy Yard, Mare Island, Cal.

Merton E. Farr, president, Detroit Ship Building Co., Detroit, Mich.

George H. Guy, secretary New York Electrical Society, 29 West Thirty-ninth street, New York City.

John C. Silva, secretary treasurer, Welin Davit & Lane & DeGroot Co., 17 Battery Place, N. Y.

Alfred A. Olcott, treasurer, Hudson River Day Line, Desbrosses street pier, New York.

William Livingstone, president Lake Carriers' Association, Detroit, Mich.

Ralph D. Williams, editor THE MARINE REVIEW, Cleveland, O.

Junior to Associate.

R. W. Berliner, V. J. Hedden & Sons Co., 1 Madison avenue, New York.

F. B. Whitaker, draughtsman, Bur. C. & R., navy department, Washington, D. C.

Junior.

Christian Rasmussen, draughtsman Great Lakes Engineering Works, Detroit, Mich.

Those in attendance at the sessions were: President F. T. Bowles, Stevenson Taylor, W. J. Baxter, W. I. Babcock, George L. Craig, Robert Logan, John R. Russel, George A. Mattsson, Samuel Ward Stanton, Charles B. Rowland, F. E. Still, R. H. Laverie, W. S. Russel, J. A. Ubsdell, M. W. Day, R. B. Sheridan, Frederick Metcalf, Charles Ward, W. G. Coxe, James M. Smith, Richard P. Joy, Ogle T. Warren, Frank E. Kirby, F. C. Pahlow, J. J. Lynn, Daniel E. Lynn, George A. White, B. W. Parker, William T. White, William Livingstone, L. W. Taylor, Thomas J. Kain, George H. Guy, F. C. Reynolds, James E. Davidson, Alexander Hynd, J. C. Silva, J. W. Kellogg, Ira W. Harris, R. S. Riley, H. L. Hibbard, W. C. Nickerson, J. J. Crain, Lee Hopkins, H. Penton, T. S. Kemble, J. G. Kreer, E. G. Todt, Frank Jeffrey, A. G. Smith, D. M. Luehrs, Dwight True, H. C. Sadler, H. D. Goulder, John Craig, George L. Craig, and Lieut. F. P. Camperio of the Royal Italian navy.

Opening of the Sessions.

The mornings were devoted to the reading and discussion of papers and the afternoons to pleasure. On Friday afternoon the members went to St. Clair flats on the U. S. S. San Juan de Austria, and had dinner at the Old Club; on Saturday afternoon they went automobile riding in the parks and boulevards with tea at the Country Club.

Aside from the reading of the papers the only business transacted was the adoption of the following resolution by the council:

"Resolved, That any line officer of the navy who has reached the age of 25 years (who has received his first commission subsequent to 1899) and who shall have served afloat for at least three years subsequent to commissioning shall be considered qualified as a marine or mechanical engineer within the meaning of article II, paragraph 2 of the constitution."

In opening the meeting on Friday morning for the reading and discussion of papers, President Bowles said that their first sumer meeting was under most distinguished auspices and that the society would endeavor to show its appreciation. A number of letters of regret were then read by Prof. H. C. Sadler, who acted as secretary.

Model Experiments on Suction of Vessels.

The first paper considered was naval constructor D. W. Taylor's paper on "Some Model Experiments on Suction of Vessels," which, in the absence of Mr. Taylor, was read by Mr. Sadler. This paper was as follows:

The question of the relative reactions of vessels under way and close to one another is one of great complication. That these reactions are strong is well known and the cases of suction due to them when vessels have made ill-advised attempts to pass others too closely are well known.

That the question of suction is not one always involving danger is shown by Fig. 1, which shows a formation used some years ago by United States torpedo boat destroyers when exercising under way. This figure shows approximately relative positions of the vessels and I am informed by Lieutenant-Commander Chandler, who was in charge of the squadron, that at times they used this formation at quite high speeds, twenty knots and over.

Some experimental investigation of this question has been made at the Model Basin within the last year. The apparatus used was more or less of an improvised nature.

It was found during the experiments that as might be anticipated, there was more or less instability about the reactions involved, it being very hard to tow the models exactly straight, so that the results obtained cannot be regarded as highly accurate, but they show tendencies and the general nature of the phenomena very distinctly.

Four models were used, all of 3,000 lb. displacement. Their dimensions, etc., are given below.

Table of Model Dimensions and Coefficients.

Length of all on water-line..20.512 ft.
Length mean immersed......20.000 ft.
Displacement in fresh water.3,000 lb.

Model number.	B beam, feet.	H draught, feet.	B/H.	Longitudinal coefficient, l.	Midship section coefficient, m.	Block coefficient, b.
834	3.692	1.263	2.92	0.56	0.90	0.504
838	3.503	1.198	2.92	0.56	1.00	0.56
858	3.586	0.957	3.75	0.74	0.925	0.685
866	2.778	1.235	2.25	0.74	0.925	0.685

These models were towed in pairs abreast one another or at definite distances ahead or astern. In the abreast positions they were towed at various distances apart. For other positions, the uniform distance apart of their center lines was 3.90 ft., or nineteen-hundredths of the length of the model. While this is quite close, it should be remembered that these experiments were made in water many times the draught of the models and hence the suction effects under given conditions would be less than if the water had been shallow as is usually the case when suction phenomena are of importance in connection with actual ships.

The pulls or repulsions were measured at two points, near the bow and near the stern, as indicated in Figs. 4 and 5. It was found that within the limits of error the forces acting for a given relative location of the models varied with speed as the resistance of the model. This fact

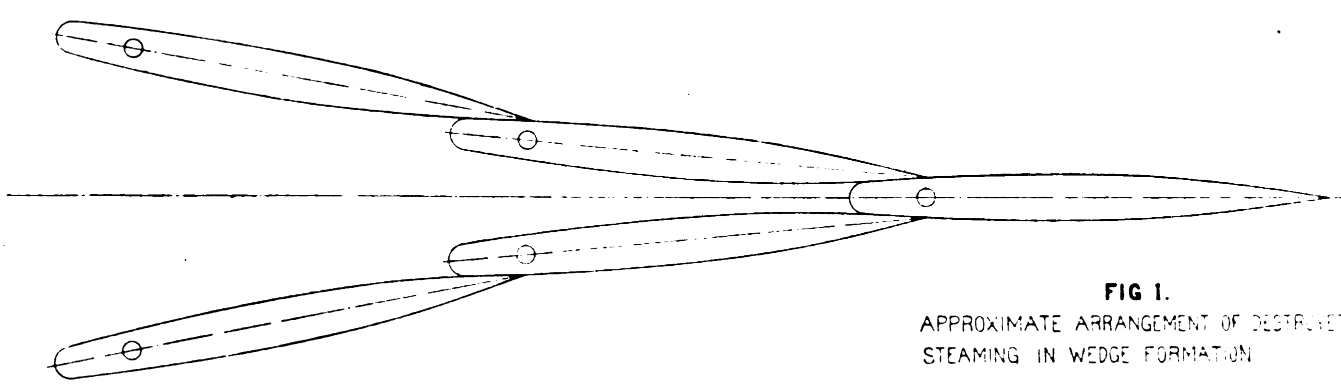
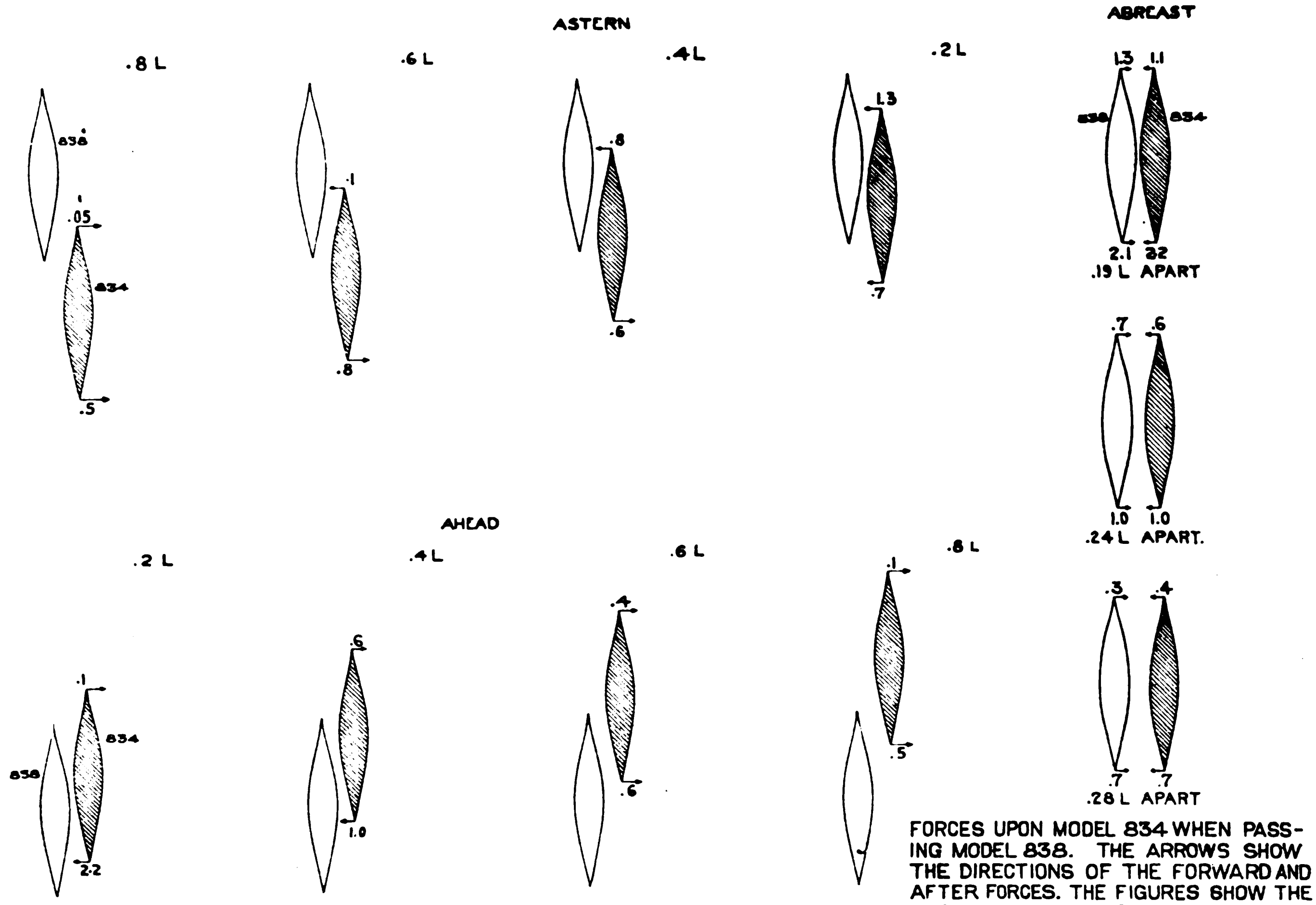


FIG 1.
APPROXIMATE ARRANGEMENT OF DESTROYERS STEAMING IN WEDGE FORMATION



FORCES UPON MODEL 834 WHEN PASSING MODEL 838. THE ARROWS SHOW THE DIRECTIONS OF THE FORWARD AND AFTER FORCES. THE FIGURES SHOW THE AMOUNTS EXPRESSED AS FRACTIONS OF THE TOTAL RESISTANCE.

SPEED OF MODELS 2 TO 3 KNOTS

FIG. 2.

was taken advantage of to plot the forces in terms of the model resistance. This model resistance is that of the model when towed independently. The effect of the side suction upon resistance was not measured.

Figs. 2, 3, 4 and 5 show the results obtained. Fig. 2 shows the pulls and repulsions upon model 834 as it passes model 838. It also shows, for the position abreast, the reactions upon both models 834 and 838 for three spacings. Fig. 3 refers to models 858 and 866, showing the forces acting upon 858 as it passes 866. It also shows for the abreast position the model reactions for three spacings and the actions upon model 858 for greater distances apart. Fig. 4 shows curves of the pulls and repulsions upon model 834, corresponding to Fig. 2, and Fig. 5 shows the same for model 858, corresponding to Fig. 3. In Figs. 4 and 5, the zero position means that the centers of the two models are abreast one another. Their center lines were 3.9 ft. apart which was maintained throughout.

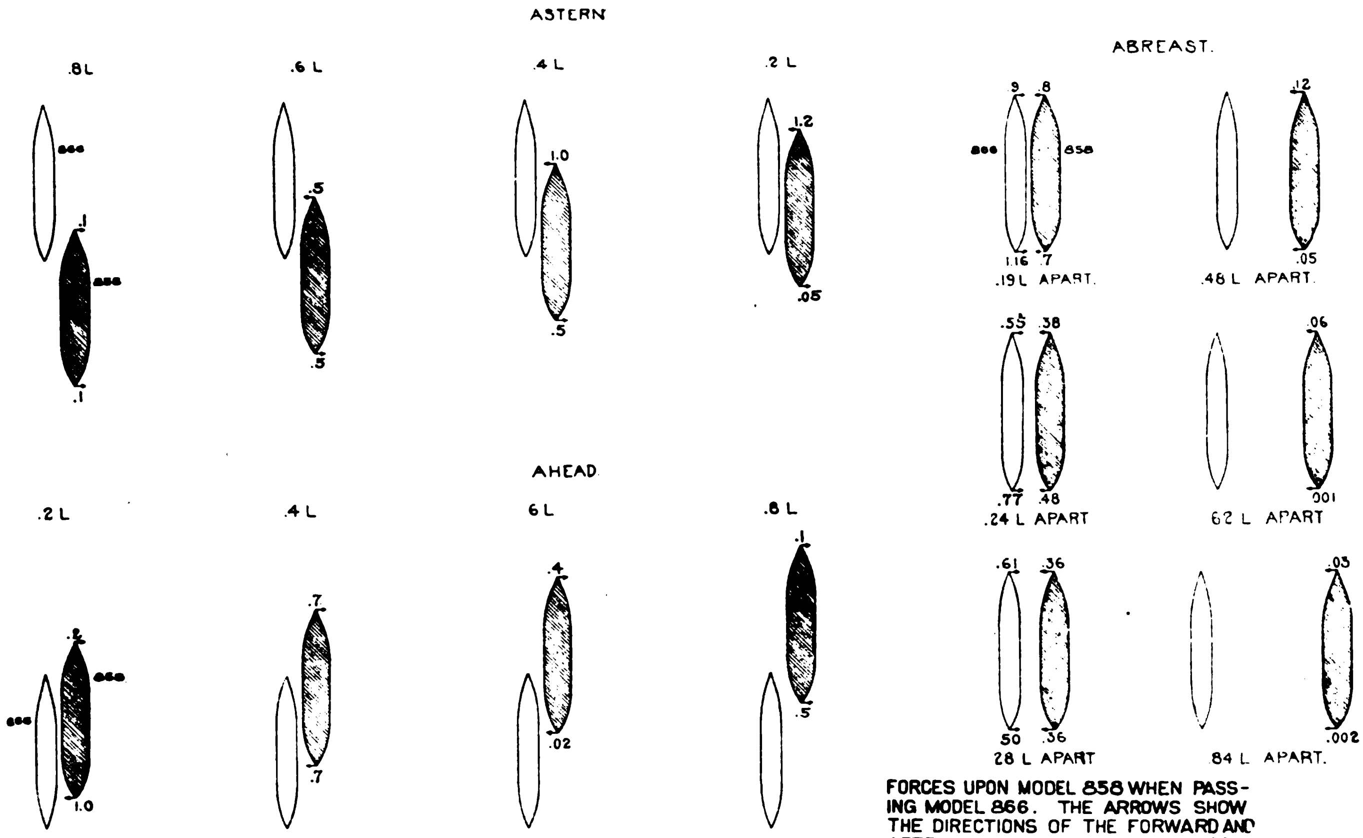
The position two-tenths ahead means that the center of model 834 is two-tenths of its length forward of the center of model 838, while in the position five-tenths ahead, the center of model 834 is abreast the bow of model 838, while in the position five-tenths astern, the center of 834 is abreast the stern of 838. It will be observed that models 834 and 838 were very similar, the main difference being that one had a finer midship section than the other but both of them were of the fine type. Models 858 and 866 were similar in coefficients, etc., but 858 was broad and shallow while 866 was narrow and deep.

The results obtained from the fine models were somewhat more consistent than those obtained from the full models, the latter being apparently more erratic. Broadly speaking, however, the results are in general accord and appear to indicate that when one vessel overtakes another on a parallel line, quite close to the latter, the sequence of phenomena is about as follows:

When the overtaking vessel just begins to overlap the other, there is little force acting. There appears to be a repulsion at both bow and stern and curiously enough the repelling force upon the stern appears to be greater than that upon the bow. The resulting tendency is for the overtaking vessel to turn in toward the overtaken vessel. When partially overlapping, the tendency as in the 0.6-*L* position in Figs. 2 and 3 is for the bow to be drawn in while the stern is still repelled. In this connection Fig. 1 is of interest, as it indicates that the natural position assumed by the torpedo boat destroyers with the stern canted out and the bow drawn in, agrees with the tendencies shown in Figs. 2 and 3 for the 0.6-*L* position.

As the overtaking vessel continues to pull up, the suction at the bow becomes stronger and the repulsion of the stern falls off, until, as they come abreast, there is a rapid change in the stern force, which shifts from repulsion to strong suction.

As the overtaking vessel draws ahead, there is a reversal of conditions, the bow pull falling off rapidly and soon becoming a repulsion, while the stern pull becomes stronger, reaching its maximum when the center of the overtaking vessel is about two-tenths its length ahead the center of the overtaken vessl. It should



FORCES UPON MODEL 858 WHEN PASSING MODEL 866. THE ARROWS SHOW THE DIRECTIONS OF THE FORWARD AND AFTER FORCES. THE FIGURES SHOW THE AMOUNTS EXPRESSED AS FRACTIONS OF THE TOTAL RESISTANCE.

SPEED OF MODELS 2 TO 3 KNOTS

FIG. 3.

be understood that the idea of the right hand vessel overtaking the other is simply used for convenience in description. For given relative positions the forces upon the right hand vessel would be the same whether overtaking or overtaken.

The figures illustrate the difficulties which are known to exist in avoiding collisions after certain positions are reached. Thus in Fig. 2, consider the position where the overtaking vessel is 0.4-L astern. There is here a strong tendency to swing the bow in toward the other vessel and cant the stern out. If the rudder is put to starboard with the idea of throwing the bow out, the result will be either a diminution of the force at the stern which is pulling the stern to starboard, or its reversal, there being substituted for it a force which will push the stern to port. If the force is not reversed there will still be a tendency to swing the bow closer to the overtaken vessel. If the repulsive force is more than balanced

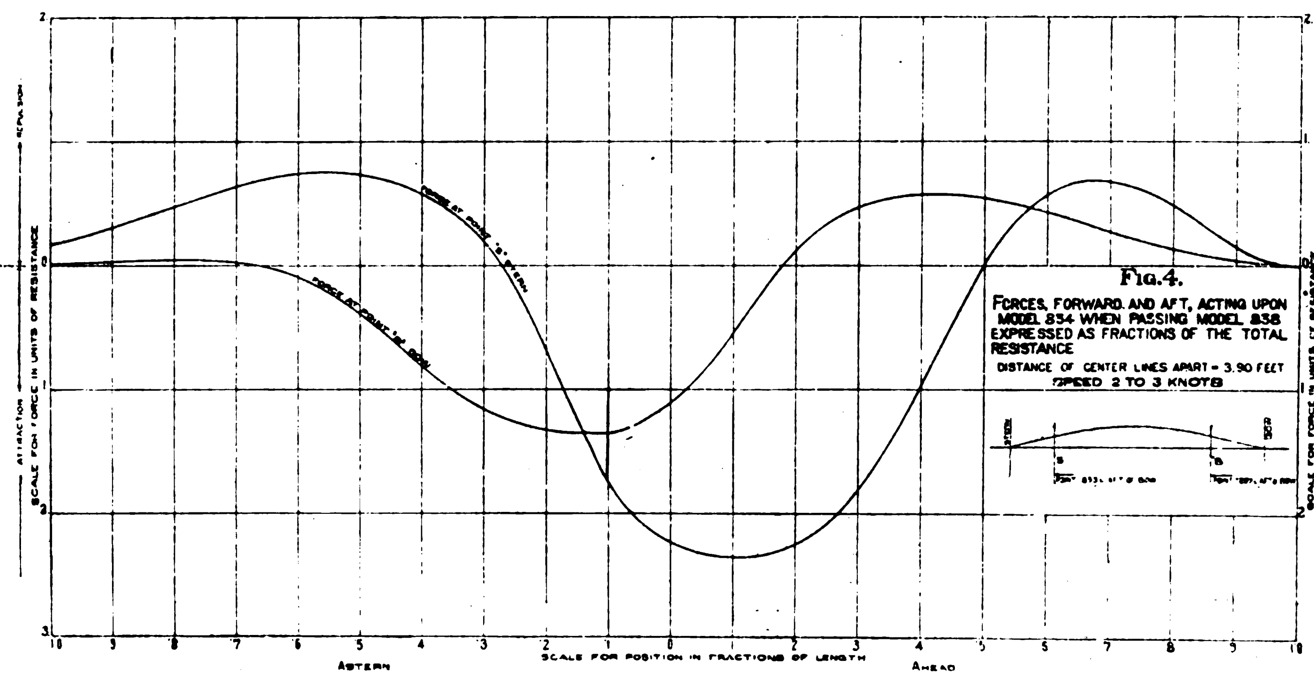


FIG. 4.

FORCES, FORWARD AND AFT, ACTING UPON MODEL 834 WHEN PASSING MODEL 838 EXPRESSED AS FRACTIONS OF THE TOTAL RESISTANCE

DISTANCE OF CENTER LINES APART = 3.90 FEET
SPEED 2 TO 3 KNOTS

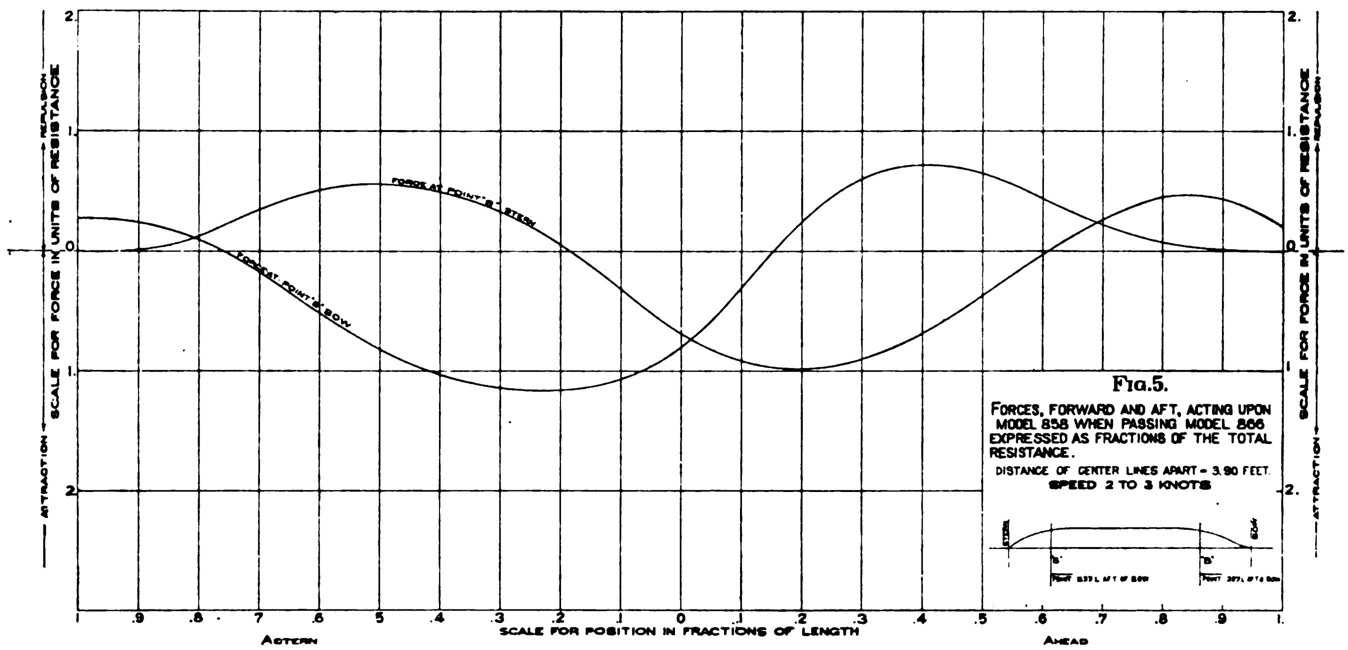


FIG. 5.

FORCES, FORWARD AND AFT, ACTING UPON MODEL 858 WHEN PASSING MODEL 866 EXPRESSED AS FRACTIONS OF THE TOTAL RESISTANCE.

DISTANCE OF CENTER LINES APART = 3.90 FEET.

SPEED 2 TO 3 KNOTS

we shall have both at bow and stern forces pulling the vessel bodily to port, and probably this will be sufficiently great to bring the vessels together regardless of the rudder action.

In the experiments the models were not allowed to obey the forces set up, being compelled to remain parallel to one another. In the case of a vessel actually overtaking another, the conditions would be different, since the vessel would always respond to the forces corresponding to its position, unless neutralized by the action of the rudder.

Fig. 3 showing the action upon model 858 when abreast of model 866 and at some distance from it indicates that the forces involved fall off quite rapidly as the vessels get farther apart. The forces are, however, quite appreciable when the vessels are as much as one-third of their length apart.

In considering the application of these results to cases arising in practice it has already been pointed out that in practice vessels approaching one another closely are usually in shallow channels, where the forces may be expected to be greater than in deep water. Another difference is the fact that actual vessels are self-propelled and it is frequently supposed that the suction of the propeller has much to do with the phenomena produced.

In this connection, however, it should be pointed out that we have some line upon what the suction of the propeller can do from our knowledge as to the thrust deduction on actual vessels. The thrust deduction of a vessel is simply the suction of its own propeller upon the after part. Now, except for very full single screw vessels, the thrust deduction will seldom amount to as much as twenty per cent of the resistance. This being the case, considering Figs. 2, 3, 4 and 5, it is difficult to see how the suction of the propeller upon the vessel at an appreciable distance can be as much as four or five per cent of the propeller thrust or the resistance, while the forces found from the bare model reactions are very much larger. This, of course, does not apply to the wash from the propeller, but the wash is restricted to a comparatively narrow belt immediately astern and hence cannot be said to play an important part in suction phenomena.

In conclusion I desire to record that the experiments upon which this paper is based were carried out under the direct charge of Mr. L. F. Hewins assisted by Mr. George Thorne, both of the Model Basin staff.

Discussion on Taylor's Paper.

Capt. George A. White.—I have had some talk with Mr. Taylor on suction and I think it the beginning of a most important discussion. Along with the question of suction comes the question of wave reaction. Mr. Taylor does not seem to have considered the displacement wave. The water moves faster between the vessels and this has a tendency to force them together. Vessels have a tendency to yaw in shallow water. The difficulty of shoal water navigation cannot be too strongly dwelt upon by the naval architect. The greater part of our commerce is carried on in shallow water.

Mr. J. J. Lynn.—This paper apparently has not taken in the question of currents. I have had 30 years' observation of the action of vessels passing in a strong current at Port Huron. There seems to be a tendency for the stern to go to port and most of the collisions that occur are near the boilers. What occurs in actual practice is certainly at variance with the conclusions of this paper.

Commander W. P. White.—It seems a pity that the suction of the screw is not demonstrated by experiments. Mr. Hermon A. Kelley, general counsel for the Pittsburg Steamship Co., thinks that the screw effect is much greater than it has been given credit for. Whatever the cause, we find by actual experience the suction is greater on a steamer than if she is being towed. In certain parts of St. Mary's river the government will not permit vessels to pass even though the channel is 600 ft. wide, the current is so strong. I would suggest that Mr. Kelley be invited to express his opinion on this subject. He has proved in court that rules which may be followed safely in deep water navigation cannot be practiced in certain channels of the lakes without causing trouble, even though fundamentally sound.

John Craig.—Harvey D. Goulder has tried more collision cases than any one else and is the father of suction on the lakes. Let us hear from him.

Harvey D. Goulder.—In practical experience we find that the force of suction comes into play when, as we say, the ship smells the bottom. When a screw steamer gets over near the bank her stern will sheer to the bank. We don't find that in marked degree except where she has a screw. When

our ships are meeting there is an inclination to come together. When a ship is overtaking another in a narrow channel there is a tendency for the faster ship to carry the slower one with her. They will see-saw for miles. When the passing ship gets her stern by the boiler house of the other ship there seems to be a tendency for the overtaken ship to fall in towards the overtaking ship. When the ships are alongside the vessels are both very sensitive in the matter of steering. Masters are reluctant to check or back—everthing seems to act by contraries. Similar conditions do not always produce similar results, however. Relative speed and relative size are influential factors. Suction is severe when a deep draught ship overtakes a smaller ship though sometimes the smaller ship will sheer the larger. We call it the mysterious force of suction. We might ask this society to evolve a rule which might guide us in this particular. It is one of the things that we would like to find out. The practical way we meet it now is not to pass in the same direction unless there is ample room and ample water.

Prof. H. C. Sadler.—I would suggest that naval constructor Taylor be invited to reply to this discussion. The question of suction is a vital one to us on the lakes. At Ann Arbor we have made a few experiments in shallow water by putting in a false bottom. The behavior of the model has been erratic. The flow of water at the stern is disturbed and drawn in at the sides. The propeller effect is greater on the lakes than Mr. Taylor imagines. Mr. Goulder's remarks seem to establish the fact that suction is a very real thing. I think a series of experiments should be carried on in shallow water.

Capt. George A. White.—And remember that side-wheelers have suction also.

"A Method of Determining Pressure for Steam Turbines."

Mr. J. J. Crain then summarized Prof. C. H. Peabody's paper entitled "A Method of Determining Pressure for Steam Turbines," as follows:

The usual methods of designing steam turbines are based on adiabatic computations modified by factors to take account of the effect of steam friction. As applied to a simple steam turbine the method appears to be fairly satisfactory, provided that the friction factors can be properly assigned. But when applied to turbines which have two or more pressure stages, a complication comes from the fact that the heat which is due to steam friction remains in the steam and increases the entropy. The influence of this effect is understood by turbine designers and allowance is made for it one way or another. Writers on steam turbines usually ignore the effect or touch on it lightly. This paper gives a method that can be used with the aid of the author's Steam and Entropy Tables to determine directly the pressures of a compound steam turbine, taking into account the increase of entropy due to steam friction.

The influence of increase of entropy and the method of allowing for it are illustrated by a simple computation for a turbine with two pressure stages, such as has been used for the Curtis turbine.

In order to show the degree of precision to be expected this computation has been carried out with the precision that the table affords, and cross-interpolation is resorted to when necessary. It will be found that nearly, if not quite, as concordant results will be had if the temperatures are selected to the nearest half degree and if the nearest entropy column is taken without interpolation. In fact, for practical work it will generally be sufficient to use the entropy table without interpolation, using the nearest temperature and the nearest entropy column.

The author observes that to show that this method (or any equivalent method) is valuable for turbine design, comparison with experiments is desired. The experimental results are mostly in the hands of turbine builders and "much reticence is observed regarding their publication."

"Resistance of Some Full Types of Vessels."

There being no discussion upon Prof. Peabody's paper the meeting proceeded to consider Prof. H. C. Sadler's paper upon "The Resistance of Some Full Types of Vessels." The paper follows:

In the region of the Great Lakes, perhaps more than anywhere else, the very full type of cargo vessel predominates; and, as the meetings of the Society are to be held in Detroit this summer, the results of some experiments upon the resistance of vessels of full form may be of interest.

It may be thought that vessels having a block coefficient of from 0.80 to 0.86 and a prismatic coefficient of from 0.83 to 0.89 do not offer much opportunity for appreciable variation of form under given conditions as to dimensions. It may also be questioned if such changes as are possible will produce a marked effect upon the resistance or indicated horsepower, because, at the speeds common in vessels of this type, the surface friction represents the principal part of the resistance.

The problem in a somewhat different form is constantly arising in practice, and is generally one where additional carrying capacity is required upon limited dimensions without appreciable addition to the horsepower, the speed remaining constant.

Although the subject has not been investigated to its fullest extent, the results given below show the possibilities of improvement in the form of vessels of this type, and also give a certain amount of data which may be useful.

Figures 1 and 1a show the curves of sectional areas and the body plan of a wide and shallow type with the following coefficients:

$\frac{L}{B}$	4.35	4.35	4.35
$\frac{B}{d}$	6.17	4.625	3.7
Block coefficient	0.822	0.845	0.858
Prismatic coefficient...	0.839	0.858	0.870
Midship section coefficient	0.98	0.985	0.986

The model was tried at three draughts and the curves of residuary resistance per ton of displacement are shown in Fig. 2.

At the deepest draught the counter was partially immersed in still water, but as this also happened at the lesser draughts when the model attained moderate speeds, the conditions are practically similar.

Time did not permit any modifications in this form, which, as will be seen, is of a ship-shape character; but, in all probability, as good if not better results might have been obtained by adopting a more typical "scow" form, especially at the speeds usual for this type.

The body plans and sectional area curves of the next series to which attention is called are shown on Figs. 3 and 3a. In this series certain modifications of form were made which consisted mainly in fining the lower part of the sections at some distance from the bow and also easing the form where the fore body joined the parallel midship body. The displacement, therefore, varies for each modification as shown in the following table:

	I.	II.	III.
$\frac{L}{B}$	5.81	5.81	5.81
$\frac{B}{d}$	3.0	3.0	3.0
Block coefficient	0.814	0.804	0.782
Prismatic coefficient...	0.831	0.821	0.798
Midship section coefficient	0.980	0.980	0.980

The curves of residuary resistance are shown in Fig. 4. The effect of even a slight modification of form is seen by comparing curves 1 and 2. For a reduction of displacement of 1.25 per cent there is a corresponding reduction of about 10 per cent in residuary resistance at speed-length ratios of between 0.60 and 0.70. In the case of a 300-ft. ship this would mean a reduction of about 100 I. H. P. at a speed of nearly 10.5 knots. The effect of a still further reduction is seen by comparing curves 1 and 3, and in this case the saving would amount to nearly 300 I. H. P. at the above speed. In both the above cases it should be remembered that, although the displacement is decreased, there is a corresponding decrease in weight of machinery and coal, and the balance from a commercial standpoint might sometimes be in favor of the finer vessel.

Attention is also called to the fact that, although the residuary resistance per ton of displacement shows somewhat small differences, the displacement also decreases, and hence the reduction is greater than appears from the curves. The wetted surface also is slightly decreased.

The next series represent a narrower type and one approaching more nearly the ordinary lake freighter. The body plan and sectional area curves are shown in Figs. 5 and 5a. The particulars of the model are as follows:

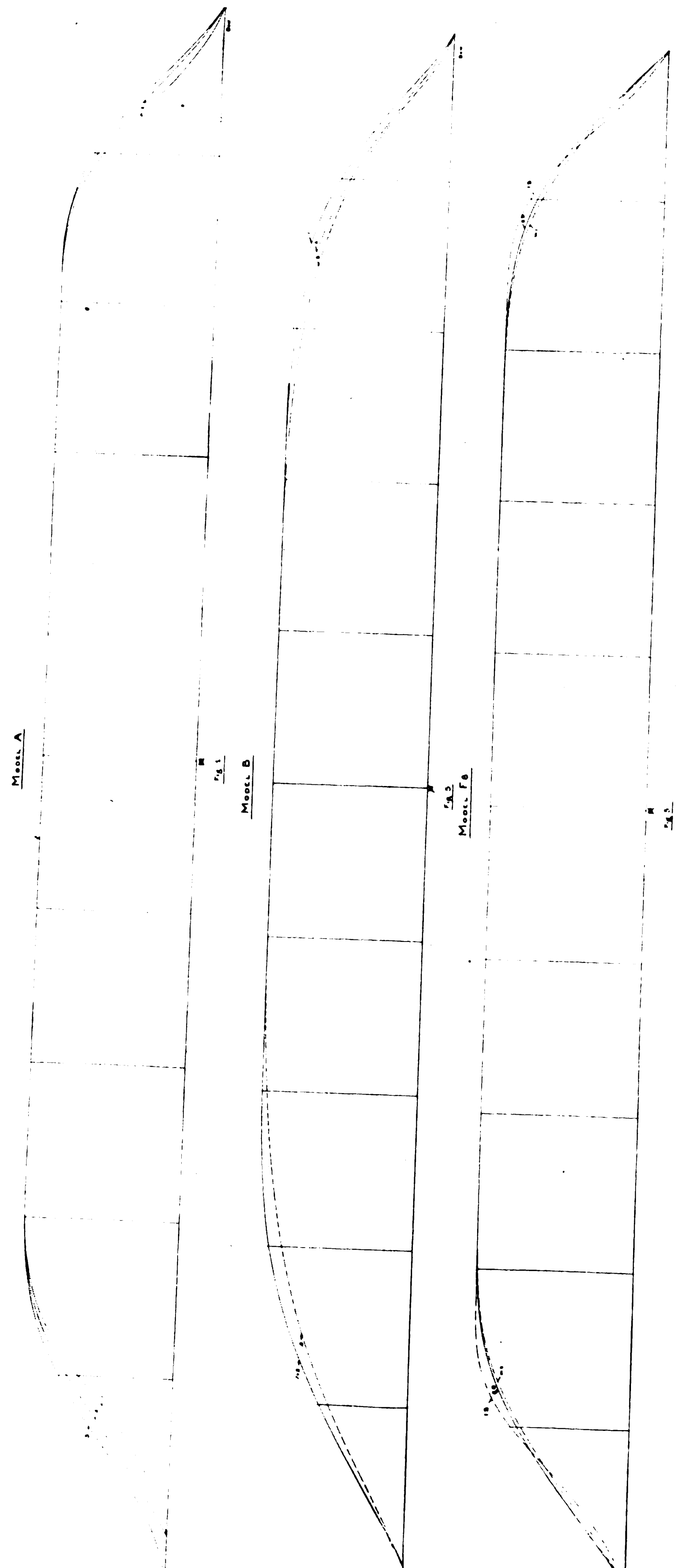
$\frac{L}{B} = 8$;

$\frac{B}{d} = 2.143$;

Block coefficient = 0.855;
Prismatic coefficient = 0.869;
Midship-section coefficient = 0.984.

The forms 1B.1S and 2B.2S are taken from the paper read last year, and call for no further comment. They are added for the sake of comparison with further modifications of the better of the two forms, viz., 2B.2S.

The modifications in general are shown by the hatched portions on the body plan. First—The lower parts of the bow sections were reduced. Second—The same thing was done with the after sections. Third—The amount cut from below was added



MODEL A.

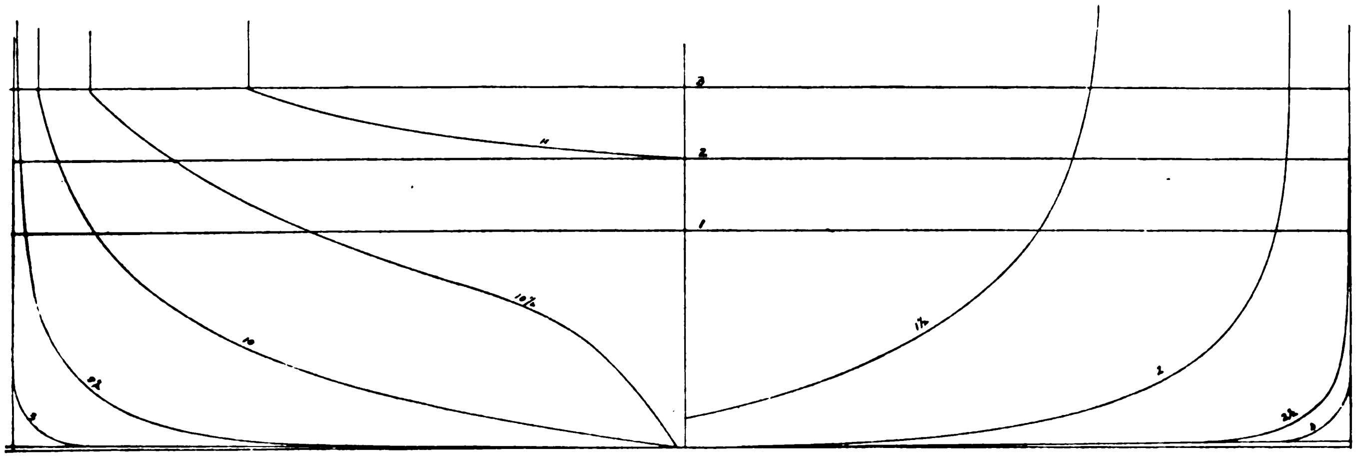


Fig 1a

to the upper part of the bow sections, thus bringing the fore body back to the original displacement. Fourth—the same thing was done with the stern sections.

In this case the maximum reduction in displacement, when both bow and stern sections were reduced, amounted to about 0.64 per cent of the total displacement, and in the final modifications (4) the displacement is the same as the original.

The results of the various modifications are shown in Fig. 6 and marked *m*1, *m*2, *m*3, *m*4.

Cutting away the lower part of the bow sections made a considerable reduction in resistance, and a similar effect was obtained with the modified stern. When the bow sections were brought back to their original areas by adding area above, little or no difference was detected in the residuary resistance per ton of displacement. With the sectional area finally the same as the original 2B.2S, but with the sections of the vessels modified by cutting away the lower part and filling out above, the residuary resistance was slightly increased as shown in curve *m*4.

A comparison of this curve with the original shows a considerable saving, while compared with the form 1B.1S, the residuary resistance has been reduced nearly 50 per cent.

As a matter of interest curves of residuary resistance have been added for shallow water. A complete series at varying depths is under investigation for this and other types, but is not yet completed. The two curves given correspond in depth of water 1.166 and 1.5 times the draught of the vessel. In the shallow water the model was run until it touched bottom, and in the deeper water until the resistance increased abnormally. The rapid rise in residuary resistance is most marked.

In conclusion it may be observed that even in full slow-speed vessels, it is possible to effect a saving in power by proper adjustment of form to the conditions demanded. An analysis of the above results indicates that it is advantageous to keep the water-line of vessels of this type rather full at both ends and to have the water-line near the bilge as easy as possible. In other words, easy buttocks at each end appear to give better results than those of a somewhat full form below and fine above.

Discussion of Prof. Sadler's Paper.

President Bowles.—This paper is undoubtedly one of great practical value and is now open for discussion.

Henry Penton: Referring to Fig. 6.

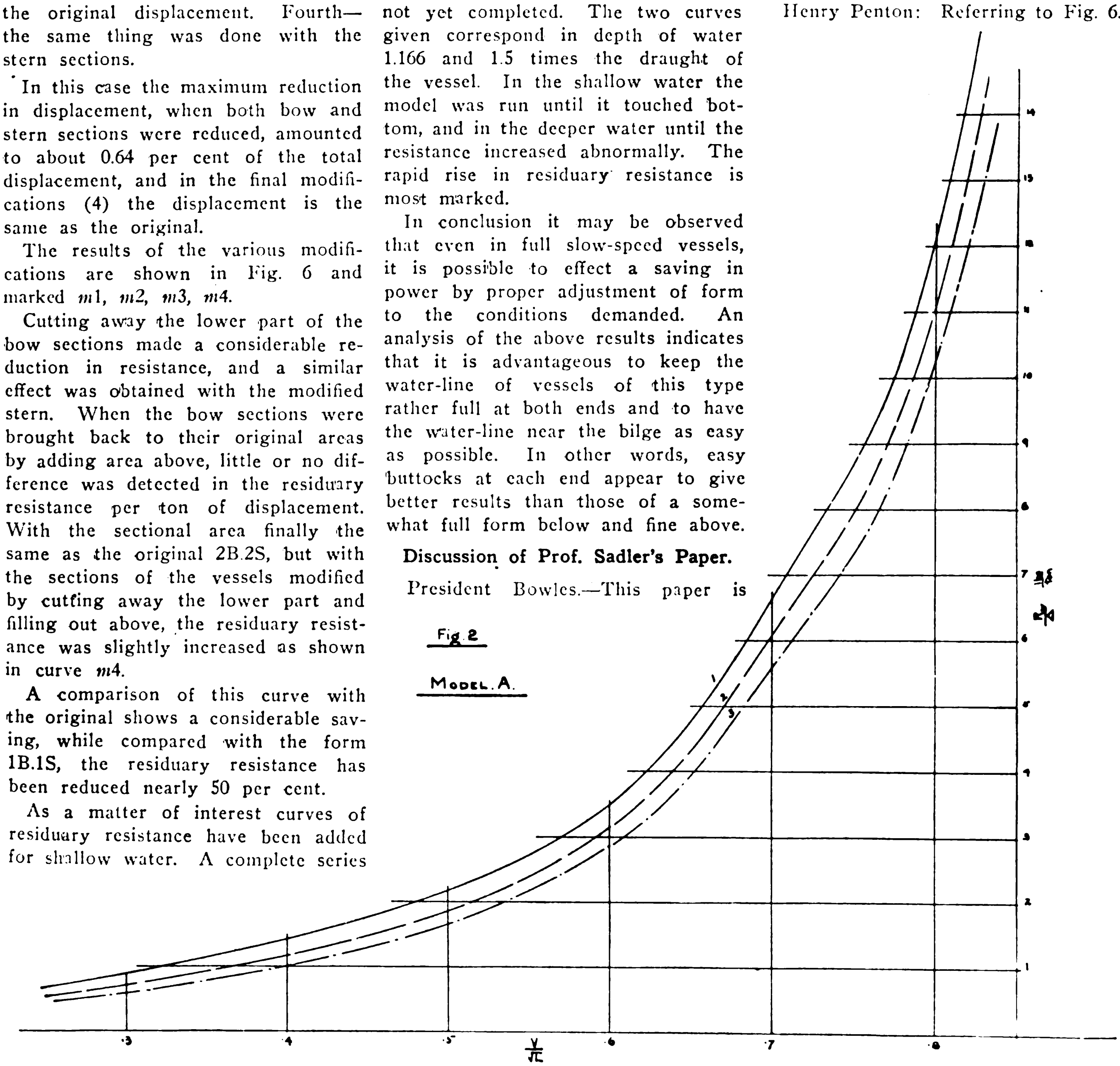


Fig. 2

MODEL. A.

MODEL. B.

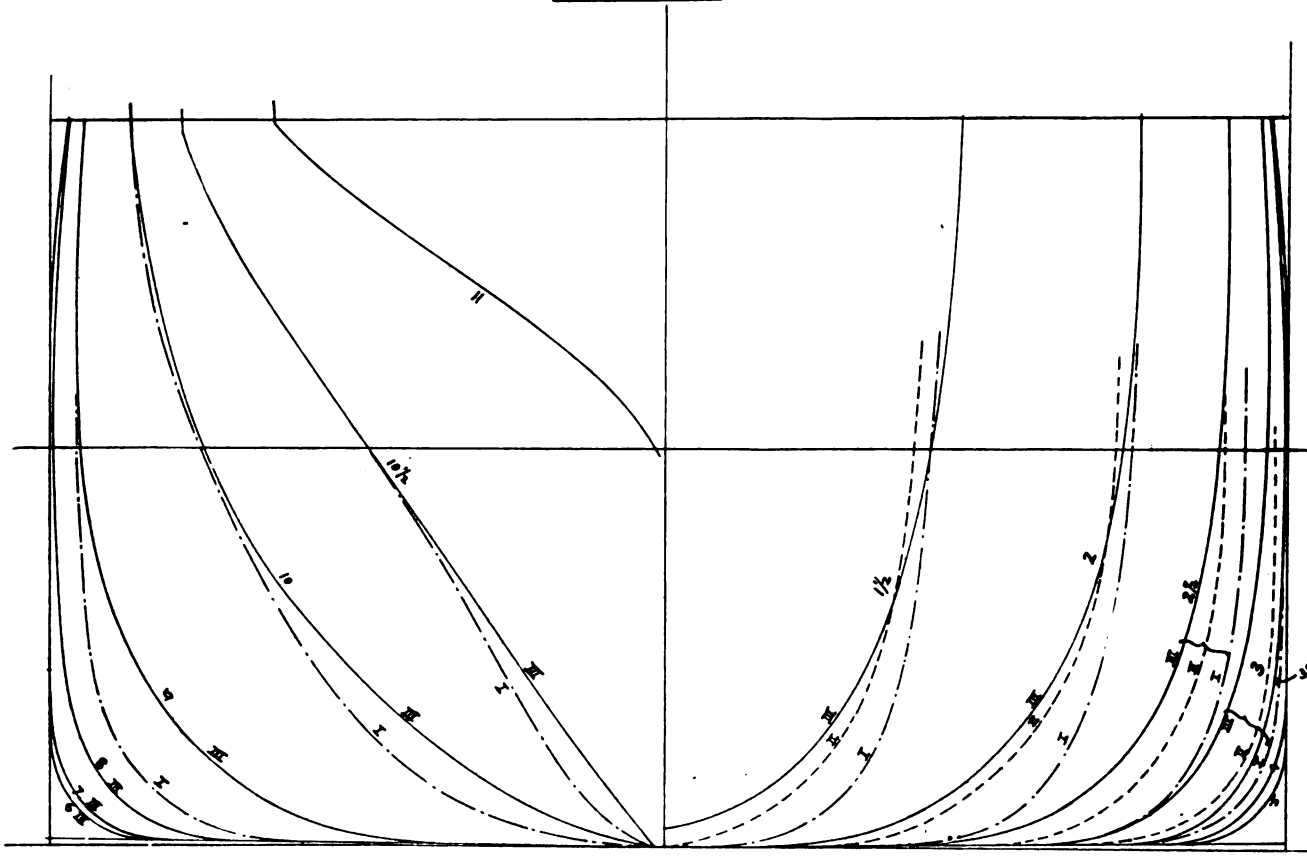


Fig. 3a.

I think the curve of resistance for a depth of water of 1.16 x draft throws a good deal of light on the subject discussed in Mr. Taylor's paper on Suction of Vessels. It accounts very largely for the evident increase in suction in shallow water, because, assuming the thrust to be constant there must be a very much greater acceleration to the water passing the stern which must set up currents over a wider area and this, I think, largely accounts for the suction observed in shallow water.

J. J. Crain.—I should like to ask Mr. Kirby how nearly these lines conform to his practice.

Frank E. Kirby.—My practice is to make them as full as possible at the water line and fine below, making easy buttock lines. Inasmuch as the draught is limited to 20 ft. and beam from 50 to 60 ft., it goes without saying that water will go the 20 ft. under the ship in preference to going around, following obviously the line of least resistance.

Prof. H. C. Sadler.—Mr. Penton has brought out a very good point. The curve of resistance in shallow water shows that there is considerable breaking up of flow at the stern. With regard to final development both forms exist on the lakes today—that is, are actually running on the lakes. The design 2B 2S shows a saving of 200 H. P. on a total of 1,800 H. P. over 1B 1S. Figure the saving in coal in one year.

President Bowles.—We should like to hear from Mr. Babcock on this subject.

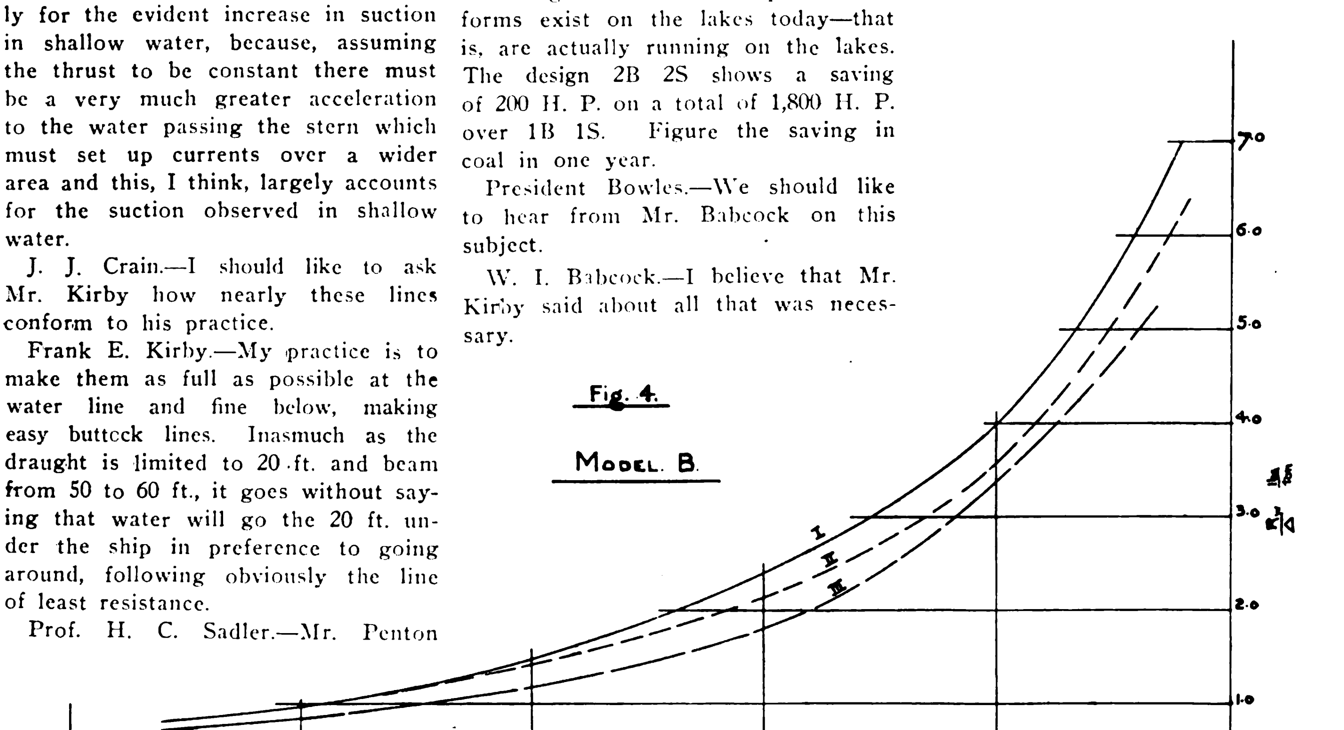
W. I. Babcock.—I believe that Mr. Kirby said about all that was necessary.

"The U. S. S. Michigan Renamed the Wolverine."

Commander W. P. White then read the paper entitled "The U. S. S. Mich-

Fig. 4.

MODEL. B.



F. 8. with modifications

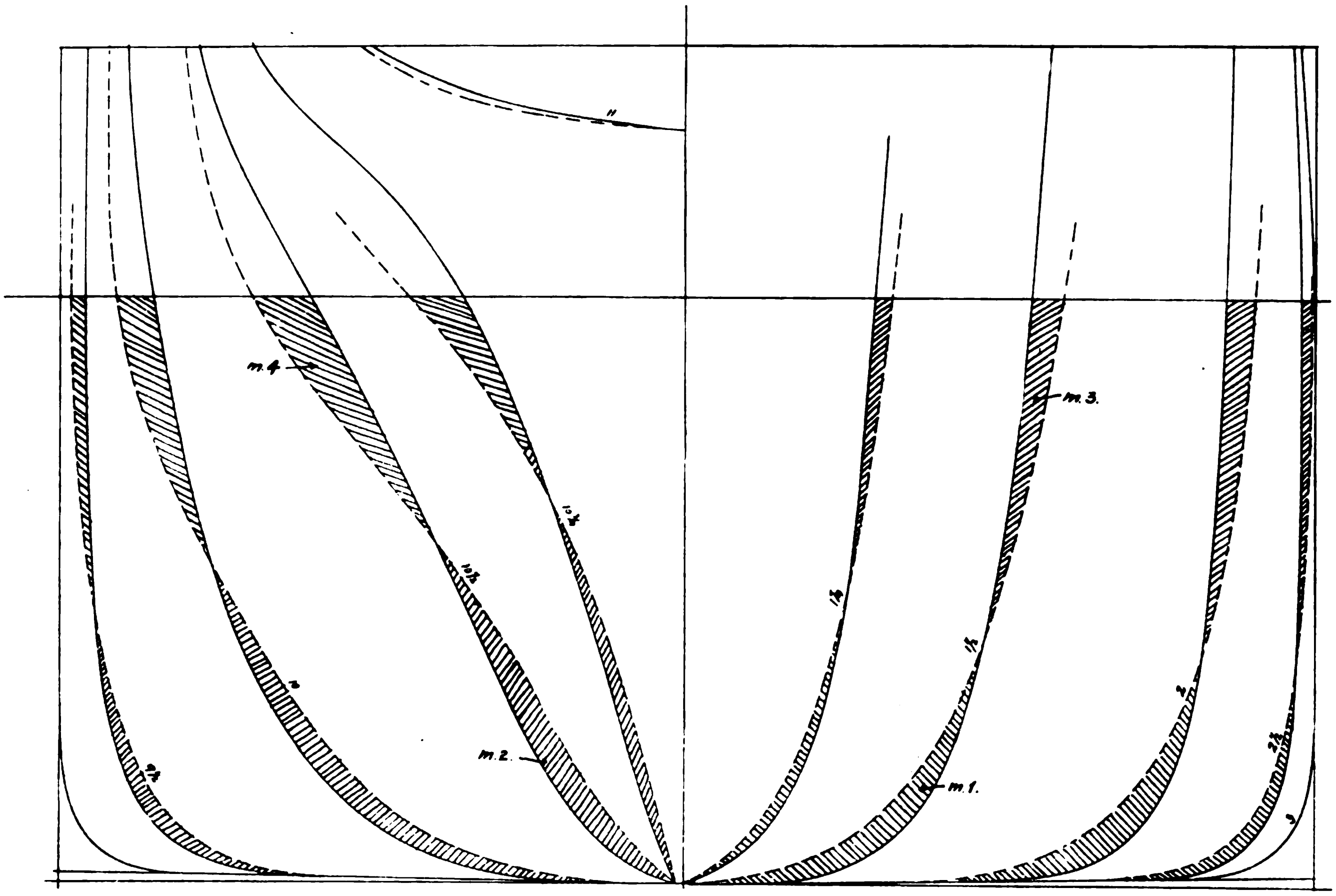
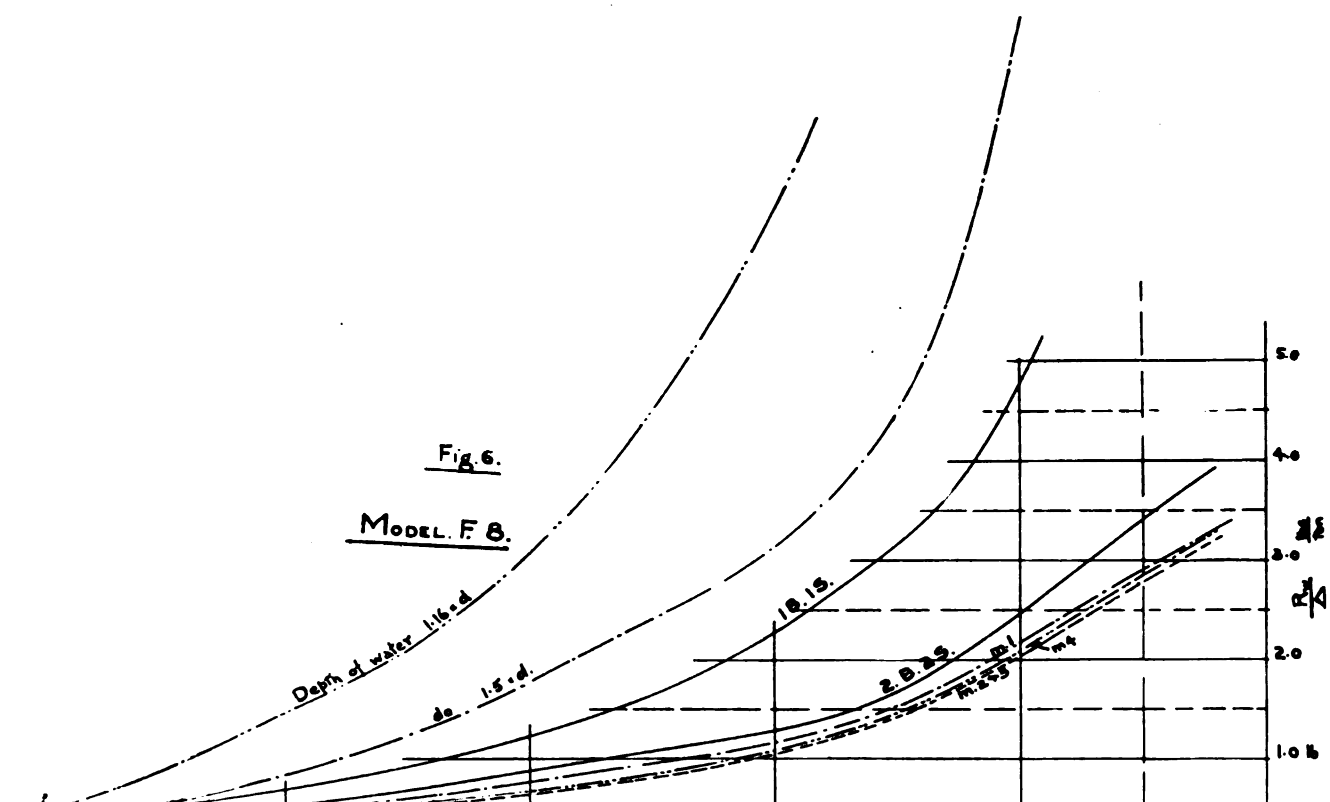


Fig. 5a



igan Renamed the Wolverine." It was as follows:

Mr. Penton, in a paper published in the last Proceedings of the Society, has given the salient points concerning this interesting old vessel, and the further information which I may give is mainly of interest, only as completing his paper.

An Act of Congress, approved September 9, 1841, appropriated one hundred thousand dollars "for the construction and armament of such armed steamers or other vessels for the defense of the northwestern lakes, as the President thinks proper and as may be authorized by the existing stipulations between this and the British Government."

The Secretary of the Navy in his annual report submitted to Congress, December 4, 1841, says, "I have taken measures for the construction of a steamer on Lake Erie, in compliance with this act, and in answer to a Senate Resolution of March 17, 1842, submitted a letter from the Board of Navy Commissioners, giving their explanation of the cause of the delay, as follows:

"March 22, 1842.

"Sir:—The Commissioners of the Navy have the honor to acknowledge the receipt of the Resolution of the Senate respecting the steamer to be built on Lake Erie, which was transmitted on the 19th instant for an answer, and have the honor to state as follows:

"The Board are occupied in making the preliminary arrangements for her construction, by preparing at New York, under the direction of Mr. S. Hartt, Naval Constructor, a draft of the vessel, with detail of the several portions, their form, thickness, weight, etc., etc., and the mode in which she is to be put together. A calculation also of her probable cost, with the size, quantity, and kind of *wooden materials* to be used in her construction, is also being made by the same officer, and it is expected that a report will shortly be made by him, when steps will be taken to procure the portions of each, and persons be appointed to carry on the building. As soon as the draft of an engine of suitable power and kind can be made, steps will also be taken to procure it on the most favorable terms. Great doubts and even difficulties are experienced in ascertaining the proper kind of engine for the steamer in question, as well as for the other steamers building and to be built, and the result of the operations of those which have been lately finished is looked for with anxiety, but with confidence.

"(Signed) L. W.
"For the Board of
Navy Commissioners.

"Hon. A. P. Upshur,
"Secretary of the Navy."

The Board of Navy Commissioners, in May, 1842, awarded the contract for furnishing the material and building the *iron* hull, engine, boilers, etc., of the iron steamer on Lake Erie, to Stackhouse and Tomlinson, of Pittsburg, Pa. The reasons for making the change from wood to iron are not known and there seems no record of them obtainable.

In August, 1842, the Board of Navy Commissioners was abolished, and the Bureau in the Navy Department organized, the Bureau of Construction, Equipment and Repair, as it was then officially known, taking up the work in relation to the building and repair of vessels that was previously done by the Board of Navy Commissioners, and therefore assumed the supervision of the work on the iron steamer at Erie, Pa., Naval Constructor Samuel Hartt being the superintending constructor. She was launched December 5, 1843, and on December 8, 1843, the Secretary of the Navy "informs the Bureau that the President of the United States has selected Michigan as the name of the steamer building at Erie, Pa."

Some further particulars in construction may be of interest. There are five heavy box keelsons which run nearly the entire length of the ship. The trough keel is the only drain for the five water-tight compartments under the berth deck, with simple gate valves through the bulkheads at the keel, which are not very efficient for water-excluding purposes. The frames of T iron are 4½ in. by 4 in. with reverse bars 4 in. by 2½ in. and are spaced 24 in. between centers. The plating as a rule runs in lengths of 8 ft. with an extreme width 26 in. by ⅝ in. for keel plate; ⅜ in. for hollow keel, bottom and bilge plates; 5/16 in. for side plating and run aft; and ⅜ in. for shear strake and plating carried up to the rail. The stem and stern posts are 6½ in. by 1½ in. Deck beams are T iron. The plating is lap straked, with single butt straps 5 in. wide, single riveted. The art of countersinking rivets for outside work on the hull seems a later development, for everywhere rivet heads are in evidence even under several thicknesses of paint.

The launching draught was:—Forward, 4 ft. 4 in.; aft, 3 ft. 11 in. Total launching weight, 563,169 lb.

The "Oldest Inhabitant" of Erie states that people came from the country round about for miles to see the launching with the expectation of seeing the vessel sink, because built of iron, and that on launching the vessel stuck on the ways and launched herself at night.

The ironwork of the vessel is still in a remarkably good state of preservation. There is some pitting in the hold, where at some time an inner sheathing prevented access. In the coal bunkers along the lower plates where the coal lies during the summer there are marks of deterioration, not of a serious character, and parts of the framing are badly corroded, but as the frames are spaced 2 ft. apart, repairs have not been necessary.

The engines, fitted with double poppet valves and Sickle's cut-off, are practically in as good condition as when built, all repairs to keep them in working order having been made by the ship's force. The old boilers were removed during the winter of 1992-93 and two steel boilers of the flue and return fire tube type built by the Lake Erie Boiler Works of Buffalo, N. Y., were installed and are in excellent condition. They are 9 ft. 6 in. in diameter by 15 ft. 2¾ in. in length over all; there are two furnaces in each boiler 6 ft. 6 in. long, 5 ft. 6 in. in diameter, and have each a grate surface of 22.75 sq. ft.; heating surface in each boiler, 1,286 ft. There is one smoke-stack 4 1/3 ft. in diameter, with a total height above the grate bars of 42 ft. 2 in. Total weight of boilers, 47 tons 342 lb. About 1884 the woodwork of the ship was torn out and renewed and a poop-deck cabin added; gallus framing to carry two steam launches was added in 1896, but, notwithstanding the increased draught resulting from these additions, the ship is able to make ten knots on twenty revolutions in a smooth sea with a favorable wind, for the great paddle-boxes and large pilot house are very effective back sails with a head wind.

Originally of bark rig, she has now pole masts and carries a jib and spanker only, still required for turning in narrow waters, as she answers her helm very slowly at low speed, and, in going astern, not at all.

Her original battery was to have been two 8-in. guns and four 32-lb. carronades, but, owing to the protest of the British Minister, one 18-lb. only was mounted, and with this battery

she sailed on her first cruise under the command of Commander Wm. P. Inman. During the Civil War the battery was increased and in 1864 was given as one 30-pounder, five 20-pounders, two light 12-pounders and six 24-pounders.

The name was changed to Wolverine in order that a first-class battleship, authorized by Congress March 3, 1905, might bear the name of that great state, Michigan.

The ship has been variously employed for recruiting, surveying and, notably during the Civil War, to guard the lake borders from attempted raids and the transportation of arms from Canada by Confederate agents, and as a guard for Johnson's Island, where a great number of Confederate prisoners was held.

Her original complement was one commander, two lieutenants, one master, one purser, one passed assistant surgeon, five passed midshipmen, one chief engineer, four assistant engineers, one gunner, one carpenter, twenty-three petty officers and rated men, ten seamen, ten ordinary seamen, twelve landsmen and boys, eight firemen, four coal passers and fifteen marines.

Discussion on Commander White's Paper.

Henry Penton.—I would like to ask Commander White if he discovered why her material was changed from wood to iron.

Commander White.—I tried to find out but could not. Possibly a delegation went from Pittsburg and persuaded congress to change the material in the interest of the new iron industry.

Henry Penton.—Were the boilers that were taken out in 1892 the original boilers? If so that would give them a life of about 50 years.

Commander White.—I believe they were.

John Craig.—I would like to make a few general remarks, not on this paper, but about the lakes. The art of ship owning, ship building and ship sailing on the lakes was an art until lately. The business of building, owning and sailing were curiously blended and the whole trade was marked by enormously fluctuating values. A ship might earn 100 per cent in a year, and yet again it might earn nothing and was worth nothing. But the business has now passed from an era of speculation to a sound and legitimate basis. Large companies now own many vessels and have brought stability into the business. The Pittsburg Steamship Co., controlling 112 vessels, has a broad and brilliant man at its head. Mr. Coulby, realizing the difficulties of lake navigation, annually holds a congress of his captains and their interchange of experiences is of great value. If Mr. Coulby is requested I am sure that he would give a report of these meetings to this society. It would make an interesting contribution to the November meeting.

"Towing Problems."

Mr. T. S. Kemble then presented his paper on "Towing Problems," as follows:

The subject of this paper has been announced as "Towing Problems" to leave some latitude for the introduction of any facts and theoretical considerations that might be available and pertinent to the more particular problem to which in the main it is devoted, namely, that of determining the requirements arising from given towing conditions, and the manner in which a towing machine and cable of given size will meet these requirements.

It has been found convenient to assume certain concrete figures illustrating the general method of calculation which may be applied to other conditions occurring in practice.

The normal or average pull on the tow line is due solely to the engines of the steamer, and is equal to the effective thrust of the steamer's screw, less the thrust taken up in driving the steamer itself. Waves, swerving currents, changes in steering direction and other causes may greatly alter this pull for periods of comparatively short duration.

The character of some of the forces acting on the vessels and tow line may be deduced from the following considerations:

Assume a steamer of 15,000 net tons displacement when loaded, developing 1,800 I. H. P. traveling 9 miles per hour and towing a barge of equal size and weight. Assume also a propulsive efficiency of 50 per cent, and neglect the loss due to the drag of the tow line through the water. (Note *a*). The effective thrust of the steamer screw would then be

$$\frac{1,800 \times 33,000 \times 60}{9 \times 5,280} \times 0.5 = 37.500 \text{ lbs.}$$

say 19 tons, of which half will be used in propelling the steamer itself, and the other half (9½ tons) is carried through the tow line to pull the barge. This is the average continuous pull for the conditions stated and can be readily computed for any other given conditions.

The dip or sag in the line should not be great enough to allow it to drag on the bottom. In some parts of the channels from the upper lakes to Lake Erie ports, a dip of over 20 ft. should not be permitted. This allows perhaps 30 to 35 ft., say 35 ft. below supports.

Assume a 2-in. diameter steel towing hawser of 125 tons breaking strength, about 80 tons elastic limit, weighing 6.25 lbs. per ft. in air, and about four-fifths of this, or 5 lbs. per ft. in water.

The length of this line to give 35 ft. dip with the lower 20 ft. of dip in water and with a horizontal pull of 9½ tons, is 1,027 ft. and the span is 3.22 ft. less (Note *b* and note *c*). If the steamer is slowed down as when making harbor, or meeting other vessels, the line should be correspondingly shortened as the dip would otherwise be greater at the lower speed.

Now suppose the ends of the tow line to be fastened to tow posts, and a continuous net additional force of 30 tons to come between the vessels driving them apart (Note *d*). The vessels would then be accelerated apart until the resistance in the tow line rose to

$$9\tfrac{1}{2} + 30 = 39\tfrac{1}{2} \text{ tons.}$$

At this point the dip in the line is about 10.5 ft., and the length minus span is 0.3 ft. The vessels have moved apart due to the take-up of the dip

$$3.22 - 0.3 = 2.92 \text{ ft.}$$

The stretch of the line due to the additional load may be taken as 2.23 ft. (Note *c* and Note *c*), making the total increase of span

$$2.92 + 2.23 = 5.15 \text{ ft.}$$

The average accelerating force during this time was 30/2 or 15 tons. To stop this motion apart will require an average force, additional to 39½ tons, in inverse proportion to the distance through which it acts. The distance in this particular case will be found to be about 3.5 ft. Assuming then, to begin with, that the distance through which the force acts is 3.5 ft., the average retarding force will be

$$\frac{5.15}{3.5} \times 15 = 22 \text{ tons.}$$

The maximum additional force is

$$22 \times 2 = 44 \text{ tons.}$$

making a total maximum horizontal pull of

$$39\tfrac{1}{2} + 44 = 83\tfrac{1}{2} \text{ tons.}$$

at the point where the vessels cease to move apart. The dip is about 5 ft., and the vessels have moved apart 0.225 ft. due to the take-up of the dip, and 3.275 ft. due to the stretch of the line, making in all

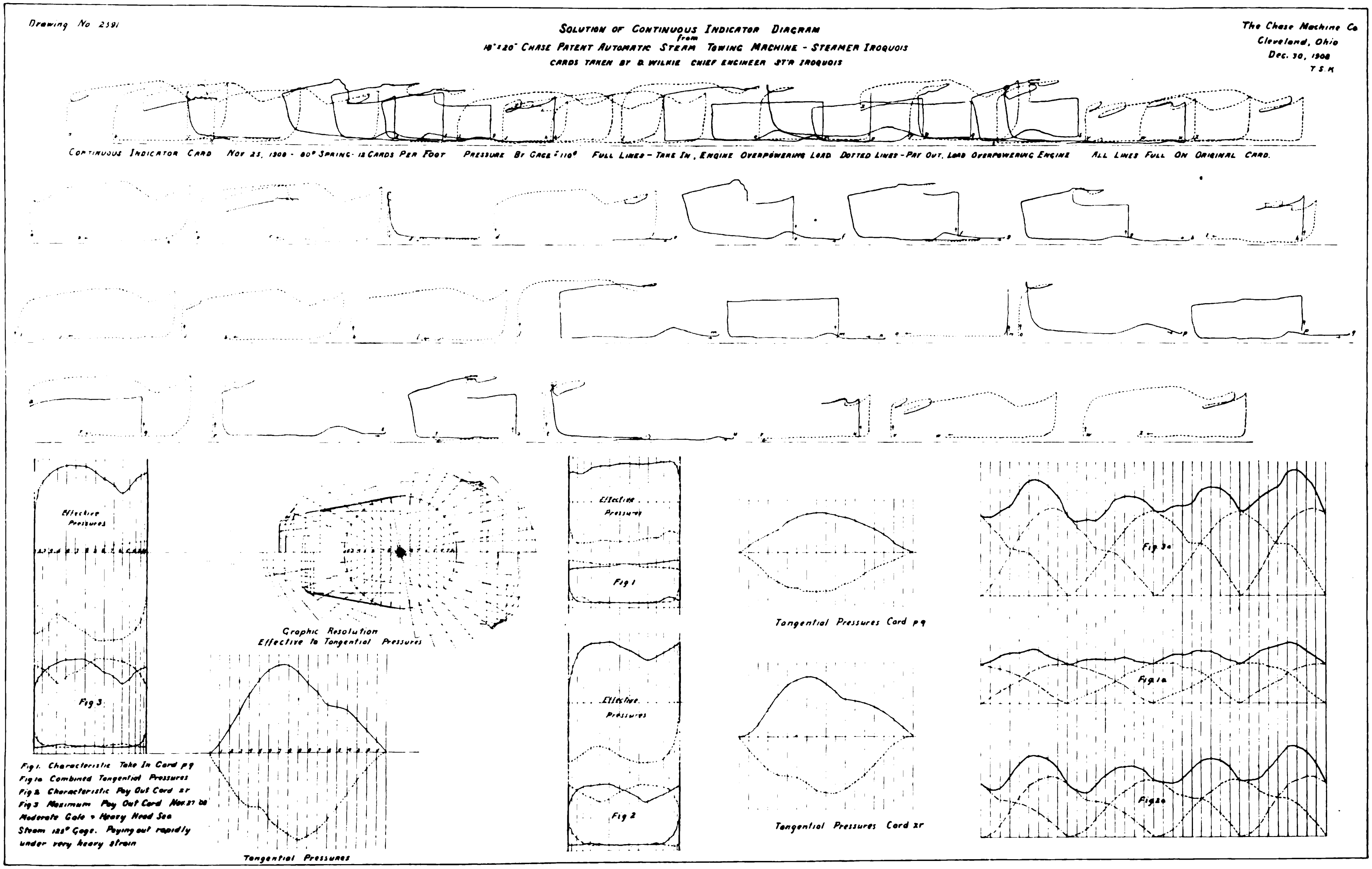

Drawing No 2591
Solution of Continuous Indicator Diagram
from
18"×20" Chase Patent Automatic Steam Towing Machine - Steamer Iroquois
Cards taken by D. Wilkie Chief Engineer St'r Iroquois
The Chase Machine Co
Cleveland, Ohio
Dec. 30, 1908
T.S.K.
Continuous Indicator Card Nov 25, 1908 - 80# Spring - 12 Cards Per Foot Pressure By Gage = 110# Full Lines - Take In, Engine Overpowering Load Dotted Lines - Pay Out, Load Overpowering Engine All Lines Full On Original Card.
Effective Pressures
Fig 3
Graphic Resolution
Effective to Tangential Pressures
Tangential Pressures
Effective Pressures
Fig 1
Effective Pressures
Fig 2
Tangential Pressures Card pq
Tangential Pressures Card xr
Fig 3a
Fig 1a
Fig 2a
Fig 1. Characteristic Take In Card pq
Fig 1a Combined Tangential Pressures
Fig 2 Characteristic Pay Out Card xr
Fig 3 Maximum Pay Out Card Nov 27 08
Moderate Gale & Heavy Head Sea
Steam 125# Gage. Paying out rapidly
under very heavy strain

PLATE No. 1.

$$0.225 + 3.275 = 3.5 \text{ ft.}$$

This checks with the original assumption (Note c_2).

It should be noted that, according to these figures a force of only 30 tons in addition to the original 9½ tons has increased the distance between the vessels 3.15 ft., due to the take-up of the dip and 5.5 ft. due to the stretch of the line, making

$$5.5 + 3.15 = 8.65 \text{ ft.}$$

in all and has put on the line a stress of 83½ tons, which exceeds the elastic limit.

A manila line with tabulated ultimate strength equal to the elastic limit of the assumed wire line would probably have stretched

$$2.23 \times 10 = 22.3 \text{ ft.}$$

in equalizing the additional load. The motion apart would have been stopped in only a trifle less than the motion apart during acceleration, and the average additional pull to stop would be about

$$\frac{22.3 + 2.92}{22.3} \times 15 = 17 \text{ tons.}$$

The maximum additional force is

$$17 \times 2 = 34 \text{ tons,}$$

making the total maximum pull

$$34 + 39.5 = 73.5 \text{ tons}$$

and a total stretch of

$$\frac{147{,}000 - 19{,}000}{160{,}000} \times 0.058 \times 1{,}027 = 48 \text{ ft.}$$

or a total increase of span of about 50 ft.

It is acknowledged that the assumptions for this problem are largely theoretical, but they were so chosen as to simplify tne problem and to illustrate the principles involved in actual practice.

The time consumed in equalizing the overload would be about 12½ seconds for the wire line, and for the manila line over 28 seconds (Note f).

Some idea of the forces actually exerted by waves tending to throw the vessels apart may be obtained from the following:

Vessels equipped with towing machines are frequently accelerated and retarded several fathoms by each of a series of waves. Mr. D. Wilkie, chief engineer steamer Iroquois, reports that at one time during a moderate gale, the towing machine was alternately paying out and recovering 15 to 18 fathoms of line. Assume conservatively for our 15,000-ton vessels a pay-out and recovery of only 2 fathoms with each wave of say eight seconds frequency (perhaps 8 ft. high, 35 per mile) acting equally in opposite directions on the two vessels. The average accelerating force on each vessel due to the waves will be

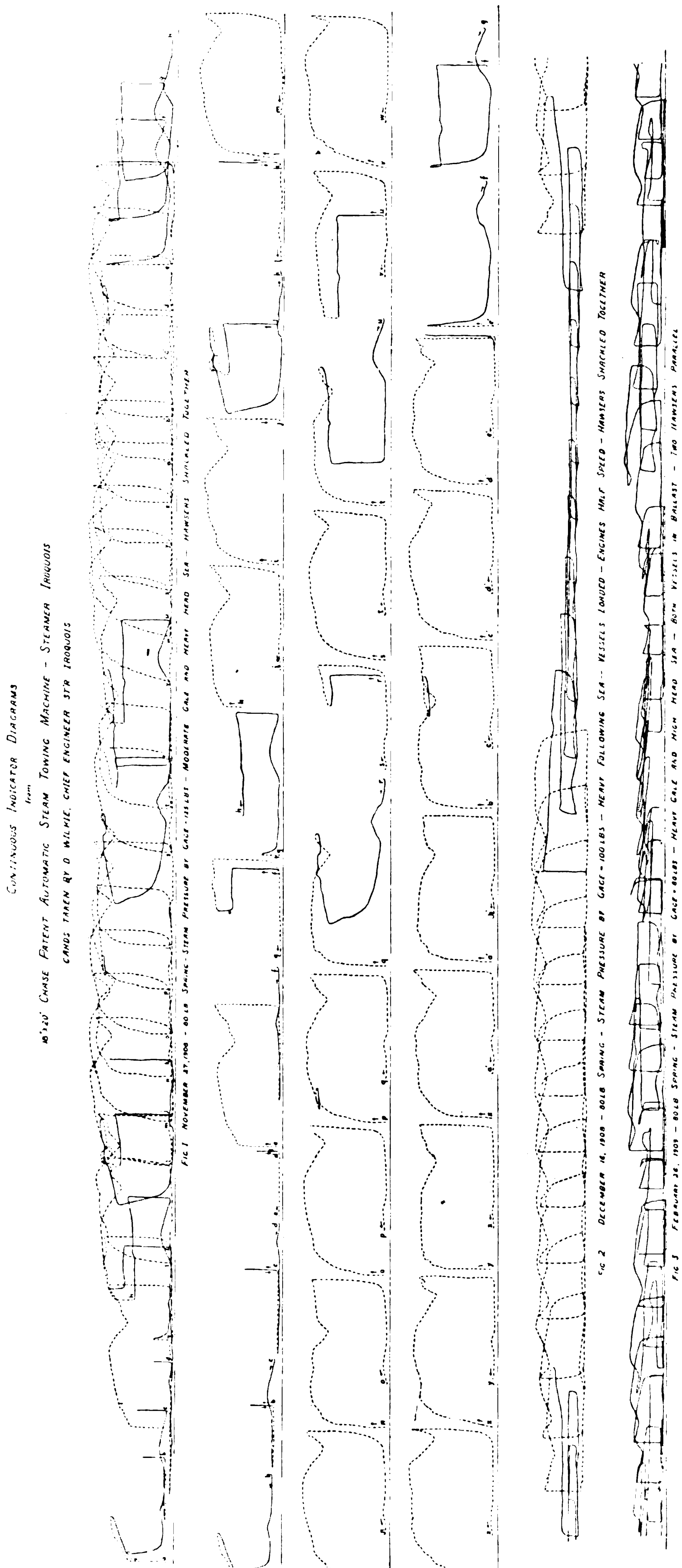


PLATE No. 2.

$$F = \frac{2ws}{gt^2} = \frac{2 \times 15{,}000 \times 12/2}{32.2 \times 42} = 350$$
tons.

This force under the conditions assumed would probably break the wire line, because the stress was found to rise above the elastic limit with an increase of span of only 8.65 ft., and a farther increase to 12 ft. would raise the stress to about the tabulated ultimate strength.

The extra stress which these same conditions would put into the manila line assumed, would be only

$$\frac{12 \times 160{,}000}{0.058 \times 1{,}027} = 32{,}000 \text{ lbs.},$$

if the increase of span had to be taken up by the stretch, unassisted by the take-up of the dip. The latter would reduce this stress to a still smaller figure.

In general these extreme forces are of short duration, and act alternately in opposite directions, though at times, as with irregular waves, two or more may act in the same direction before the vessels have completely recovered their normal relative positions. Their mean effect, however, as between the two vessels is nil, the average effect on the steamer and on the barge being the same.

Manila lines were used successfully for years, the length being such that the stretch together with the take-up of the dip was sufficient to give the required lengthening to tide over the time of stress without rupture. The expense and labor connected with the use of manila lines, their rapid deterioration, the uncertainty as to their condition and strength, and their great bulk for large vessels rendered it very desirable to discard them in favor of wire lines. The latter, however, were handicapped by their comparative lack of stretch until the introduction of the towing machine.

The steam towing machine now in commercial use is a powerful two-cylinder steam winch, fitted with a drum large enough to stow the line, and with an automatic mechanism whereby the steam pressure in the cylinder is regulated to maintain a constant length of line, so long as the pull on the line does not rise above a given point. Sudden and heavy pulls are cushioned on the steam in the cylinder, reversing the engine against the steam pressure and allowing the line to pay out till the load falls off, at which time the line is automatically wound in again to the original length.

The inertia of the vessels prevents their being thrown apart instantly, and allows the engine time to start paying out while the dip of the line is diminishing. The maximum stress in the line is limited by the engine power, so that there is no possibility of shock or of overstraining the line.

Assume for the vessels in the previous problem a 15 x 18 double cylinder towing machine with cranks set 90 degrees apart geared 5 to 1, drum 30 in. in diameter, boiler pressure 175 lbs. gage, reducing valve set for 110 lbs., and the snifting valves for 150 lbs. Neglect friction. It is recommended that there be two full layers on the drum when the proper length of line is out, and the engine would then be working on the third coil. The diameter of this coil is 40 in. The engine would be able to carry the normal load with one crank at its most effective position, and the other near dead center, with a steam pressure of

$$\frac{19{,}000 \times 20}{176.7 \times 9 \times 5} = 48 \text{ lbs.}$$

The dip would be 35 ft., and the span 3.22 ft. less than the length.

With the cranks moved up to their most effective position, the engine will hold with the same cylinder pressure, about 1.4 times this 19,000-lb. pull, or about 26,600 lbs. In being overhauled to this position, the engine will have paid out about 0.25 ft. of line. The stretch will have increased about 0.28 ft. and 1.51 ft. will have been added to the span due to the take-up of the dip, making in all

$$0.25 + 0.28 + 1.51 = 2.04 \text{ ft.}$$

If the vessels continue to be moved apart the automatic valve will admit higher pressure to the cylinders until it reaches 110 lbs. The maximum resistance offered by the engine with this pressure and working on the second layer (36 in. diameter) would be

$$\frac{110 \times 176.7 \times 1.4 \times 9 \times 5}{18} = 68{,}000 \text{ lbs.}$$

In extreme conditions, as when the barge is aground and it becomes necessary to surge on the line to free her, the reducing valve can be thrown out of commission and the snifting valves screwed down to utilize the full boiler pressure. Working with the last layer on the drum (diameter 32 in.), the available resistance to paying out would be

$$\frac{175 \times 176.7 \times 1.4 \times 9 \times 5}{16} = 121{,}700 \text{ lbs.},$$

or nearly 61 tons.

Some such limit to the extreme maximum engine power should be provided in the design to prevent breaking the line. A rigidly set brake should never be used as this gives the equivalent of a bitted line and the attendant stresses which the towing machine is designed to eliminate.

If the machine in our problem were fitted with a spring or steam set brake set to offer a resistance with the engine friction of say 14,000 lbs. to paying out and 8,000 lbs. to hauling in, the steam pressure required to hold the normal load would be reduced to

$$\frac{19{,}000 - 14{,}000 \times 48}{19{,}000} = 12\tfrac{1}{2} \text{ lbs.}$$

The resisting power of the engine to paying out would be increased seven tons for each of the last two conditions, raising the 34-ton pull to 41 tons and the 61-ton pull to 68 tons, leaving but a small margin to the elastic limit of the line. In the latter case the brake *must always* be loosened and only the steam used to take the pull.

There is an excess of power hauling in which will easily take care of the 8,000 lbs., and owing to the fact that the engine is paying out and hauling in only a very small proportion of the time there will be a considerable reduction in total steam consumption due to the reduction of leakage past the pistons with the lower pressure in the cylinder.

The first commercial towing machine was built under the Shaw and Speigle patents at the Harlan & Hollingsworth yard, in 1888, and installed on the steamer Orion.

This and its duplicate on the Saturn were both link reversing engines and the cylinder pressure was regulated by a Foster pressure regulating valve automatically adjusted from the drum shaft, according to the length of the line. These were refitted under the Metcalf patent of 1895 and provided with automatically operated slide valves in place of the pressure regulating valves.

These slide valves opened very slowly at first, allowing several fathoms of line to be paid out before full steam pressure was available. The cylinder ports on the machines built under this patent were made very small to prevent the engine from running away with the automatic valve wide open under no load.

The slow opening valves allowed the barge to get a run on the line before the full resisting power of the engine became available. This caused an excessive amount of line to be paid out, increased the danger of collision or grounding due to the

barge taking a sheer in crowded or narrow channels, and caused a needless consumption of steam in recovering the line thus payed out. The small cylinder ports choked back the steam entering and leaving the cylinders, raising the back pressure as well as lowering the initial pressure when recovering the line, thus adding to the steam consumption. In paying out rapidly (at which time the most resisting power is necessary) the small ports prevented the steam from filling the empty cylinder, after the piston reversed, in time to offer the maximum resistance.

Quick Opening Automatic Valve.

In towing machines built under later patents of Messrs. Metcalf and Dalgleish, these features have been more or less gradually discarded in favor of a quick-opening automatic valve and very large cylinder ports. In these machines as now built the automatic valve is fully opened in about two-fifths of a revolution of the drum. The steam going through the large cylinder ports fills the cylinders very quickly and opposes throughout the stroke as high resistance to paying out as it is possible to furnish. As soon as the engine begins to take in line, the automatic valve closes part way, leaving sufficient opening for ordinary working speed, but not enough to allow the engine to run away and wreck itself under no load. Thus the admission is throttled but the back pressure does not rise at the same rate as with small cylinder ports, and as a consequence less steam is used.

To farther reduce the amount of steam used and to minimize the temptation to tow on a rigidly set brake, these machines are now being supplied with spring set brake bands operating on the principle above described. In this connection it may be stated that as far as our knowledge goes nearly every accident to towing machine or hawser has been due to towing on a rigidly set brake. Certainly more accidents have been due to this one cause than to all others combined.

A range of pay-out and recovery of 36 to 45 revolutions of the drum is probably sufficient for any emergencies likely to arise.

Determining Drum Capacity.

The drum capacity for a given size of line is determined by the demands of the trade and not so far as we know by any theoretical or practical formula. In changing over from bitted manila lines to wire lines with automatic towing machines, the previous necessity for a very long manila line to give the required stretch causes a strong prejudice in favor of a very long wire line, and it has been easier to furnish machines for the length of line demanded than to make any very serious attempt to overcome the old prejudice. Some users have gradually shortened the distance between barge and steamer until they use only half or less than half the line on the drum. So long as the take-up of the dip, and the stretch of the line cannot be relied upon to give the required increase of span and an automatic towing machine is necessary, a large dip can scarcely be considered advantageous. There does not appear to be any available data concerning the power consumed in dragging the line through the water, but this factor probably much more than counterbalances any theoretical economy assumed on the ground that the machine will not have to operate so much of the time as with a small dip. It seems to the writer, therefore, that when a towing machine is installed and properly operated the tow line should be as short as certain practical considerations will allow so that the drag of the line may be reduced to a minimum and the machine and line may not be unnecesarily expensive (Note *g*). With an extremely short line the wake from the steamer would affect the barge, steering would be more difficult, and there might be danger of the vessels fouling. The effect of the wake appears to be a somewhat mooted question and the writer has suggested, as a basis for possible discussion, the arbitrary rule that the length of line in feet be made 600 times the diameter in inches and that one-third of this length be held in reserve on the drum, and be the range of automatic pay-out and recovery of the machine. Suggestions or data bearing on this subject would be very acceptable.

Government Regulations of Tows.

Long tows are a serious menace to other vessels navigating the same waters and the government regulations which went into effect Feb. 1, 1909, prescribe in part as follows:

1. "Tows of sea-going barges navigating inland waters of the United States are limited in length to four vessels, including the towing vessel or vessels."

2. "Hawsers are limited in length to 75 fathoms, measured from the stern of one vessel to the bow of the following vessel and should in all cases be as much shorter as the weather and sea will permit."

Most of the vessels at which this legislation was aimed use manila lines operated by steam gypsies. When it becomes necessary to shorten hawser the steamer must slow down and each barge takes in the slack as it overhauls the vessel ahead. This operation is laborious and involves a needless loss of time. The adoption of towing machines would save both of these items and the decrease in cost of lines would in a few seasons pay for the machines. Of vastly greater importance, however, is the fact that towing machines enable them to operate in rough weather with much shorter lines than could otherwise be used and so diminish the danger to other vessels as well as to themselves.

Indicator Cards of Iroquois.

Mr. Wilkie has kindly furnished some indicator cards taken from the 18 x 20-in. towing machine on the steamer Iroquois, while in actual service. This machine carries 3,200 ft. of 2¼-in. diameter wire line, which was originally shackled to the line from a similar engine on the barge Navahoe.

The lines are now used in parallel, the free end of each being made fast to a towing hook on the other vessel. This allows the reducing valves to be set for a lower pressure, lowers the stress on each line and reduces the length of the tow, and the dip of the line. The shackle caught on the bottom at one time previous to this while crossing the Grand Banks. The machine was towing on the automatic and no damage was done. The automatic valve movement on this machine is not so rapid as on those built later, and the machine is not equipped with the spring set brake which was developed later, but the cards may be of interest as the first that, to our knowledge, have been taken from a towing machine in actual service.

In the original cards all lines are full and in same cases rather faint. Plate 1 and Plate 2 are made from tracings of the original cards, in which those lines which appear to have been made while the engine was being overhauled are traced dotted, except in Fig. 3, Plate 2, where the card has been traced with all lines full exactly as in the original.

Parts of Card Traced Separately.

The parts of the continuous card on Plate 1 have been traced separately and lettered for reference. The same

has been done for Fig. 1, Plate 2. The following probably describes with fair accuracy what took place while the card on Plate 1 was being made:

The series opens with the machine paying out, the pressure rising and the cranks approaching their most effective position. For an instant the engine stops, then winds in an inch or so of line, but the load increases and finally runs the engine backward. The point where the pressure drops, making a dip in the upper line, is the place where the other piston reverses, and takes some of the steam out of this cylinder to help fill the other. The pressure then rises due to the steam coming in through the inlet pipe and due to the compression as both pistons advance. The next card, *b-c*, is very similar to it, but here the recovery took place in the same position in the other cylinder at which it occurred the first time in this cylinder so that the engine started to wind in when the piston was a little past the half stroke position instead of near the beginning. Again the load overpowered and it paid out for the balance of the stroke. This partial stroke was evidently so timed that it hit the knocker twice and jumped the indicator about 1½ in. instead of one. In the next card, *c-d*, the engine winds in for almost a full stroke and then pays out again, but the steam is in the other end of the cylinder and this end is open to exhaust. Just before the other end of the stroke was reached, the load overpowered again and the line paid out. In the next card, *d-e*, there was a pause and a little recovery beyond the three-quarter stroke position, then toward the middle of the back stroke the load fell off again and the engine started to wind in. The next card, *e-f*, is a typical struggling to wind in card. The admission rises sharply, then the pressure falls off slightly until the other piston gets to about the dead point, when the engine stops. The steam pressure then rises until the load begins to yield, then again in several jumps until the other crank gets in a better position to assist or the load falls off and the engine starts to wind in again. The next, *f-g*, is very like it, but here instead of the engine gaining after it stopped until the other crank got to work, it lost and moved backward a little way. A somewhat similar process taking place in the other cylinder, is indicated at the bottom of this card. The next card, *g-h*, is also similar, still winding in, losing a little at the middle position, then completing the stroke.

The next card, *h-i*, starts in the same way, but after jiggering a while, the load finally overpowers the engine and the line starts out. The next three cards are characteristic pay-out cards, though at one place in *j-k* it stopped and took in a trifle. In the card *l-m*, near the most effective crank position, the engine overpowered the load. The next card, *m-n*, is also a take-in card. The little lift that shows near one end of the back pressure line on the take-in cards is where the other cylinder opens to exhaust and raises the back pressure.

In the card *n-o* the engine pays out, the steam being in the other end of the cylinder. In the card *o-p* the engine overpowers the load and winds in with the steam in the other end and the same characteristic rise in back pressure shows when the other cylinder exhausts.

Fig. 1, Plate 1, shows the card *p-q* (a characteristic take-in card) in full lines together with *p-q* reversed in dotted lines, as the assumed card for the other end of the cylinder. At the right are shown the corresponding tangential pressures for one revolution. The full line above is the stroke over and the dotted line below is the return stroke. These are rectified (dot and dash lines) and the combined tangential pressure for one complete revolution is shown as a full line in Fig. 1a.

The same process is repeated for the characteristic pay-out card, *z-r*, also for a maximum pay-out card taken on a different date.

The back pressure on the pay-out cards, when open to exhaust, shows the back pressure in the line due to the other auxiliaries.

Fig. 1, Plate 2, is interesting in that it shows in parts of some of the pay-out cards a higher pressure than that in the admission pipe. This appears to be due to the line paying out so rapidly that even with the large cylinder ports there is some back pressure in the cylinders due to the rapidity with which the pistons force the steam back into the pipe after it has filled the cylinder at admission pipe pressure.

Interpolates a Correction.

(At this point in reading his paper Mr. Kemble interpolated the following correction: I met Mr. Wilkie when the Iroquois was last in port and asked about the steam pressure during the time that the cards on Plate 2, Fig. 1, were being taken. He stated that the steering engine was connected with the same steam and exhaust line as the towing machine, and that the average pressure as shown by the gage was about 125 lb. as reported, but that it might have risen as high as 145 lb., when neither engine was in operation. As the towing machine does not take steam when paying out, this tends to cast some doubt upon my statement that the pressure in the cylinder during parts of the pay outwards was higher than that in the admission pipe, since the margin between 145 lb. and the highest pressures indicated is only three or four lb., and this might possibly be due to inaccuracies in the instruments. The evidence would indicate, however, that the pressure in the cylinders was actually greater at times than that in the admission pipe, though the difference is not nearly so great as at first appeared.)

Fig. 2, Plate 2, did not have any atmospheric line. It begins with the end of a series of take-in cards and contains a complete series paying out, one taking in and the beginning of another paying out. This shows the more regular action which accompanies a following sea where the interval between the waves is greater than with a head sea.

Fig. 3, Plate 2, was taken towing with two hawsers. With this method of towing it was found to be possible to reduce the pressure in the admission pipe to 80 pounds and thus to reduce the stress in the line and to shorten the length of the tow without sacrificing any advantage whatever.

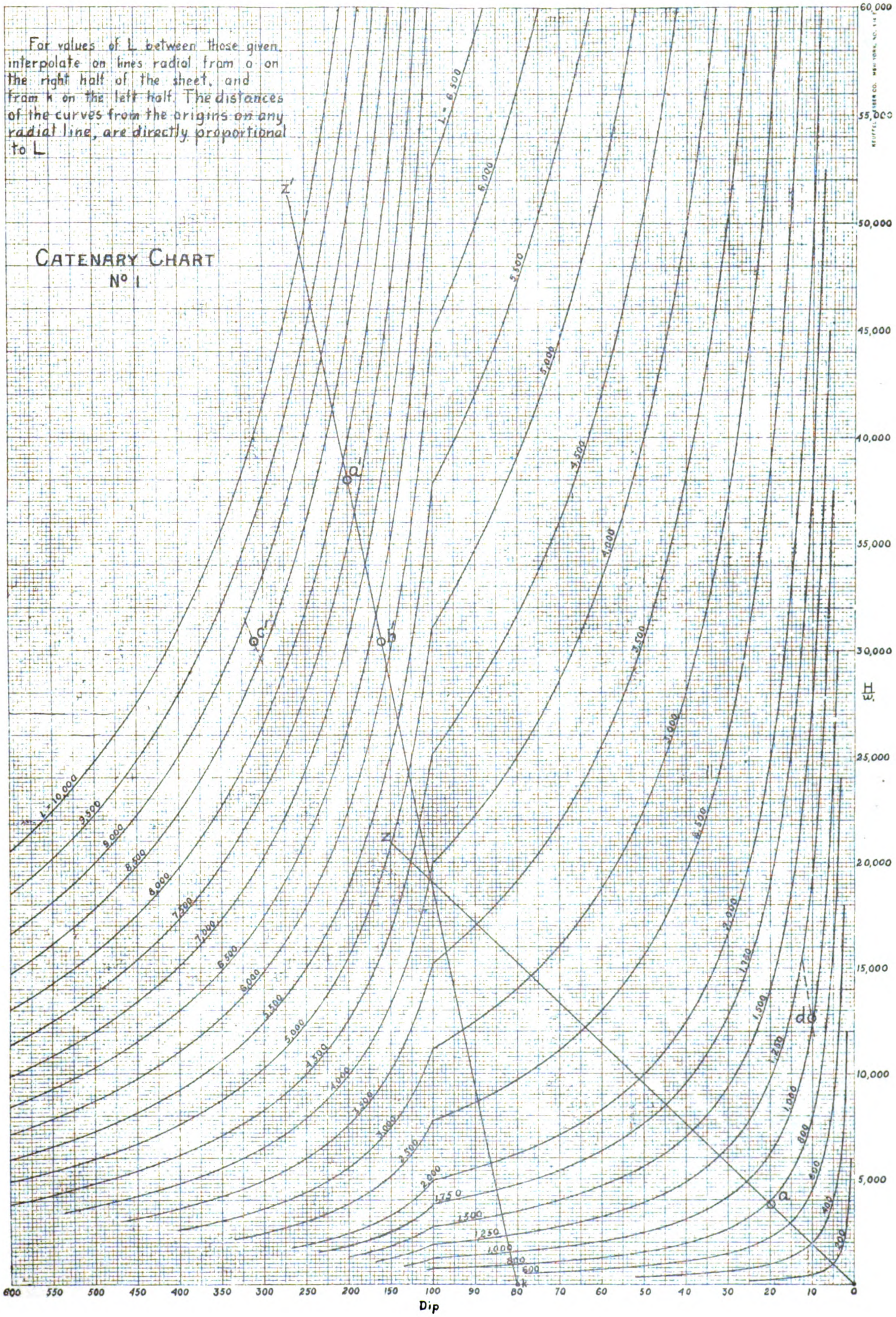
These cards would be more valuable if we were able to know the time element throughout. The difficulty of obtaining this aboard ship will be readily appreciated, but the writer hopes to be able at some future time to make report on similar cards with this factor included.

He wishes to here express his appreciation of Mr. Wilkie's hearty co-operation, and also of the assistance of Mr. Henry Penton while this paper was in preparation.

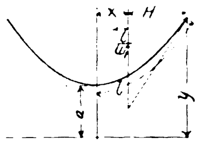
Notes.

(*a*) This loss is probably considerable with tow lines of extreme length, and should not be lost sight of in considering the proper length of tow line for any given case. There appears, however, to be no definite data on the subject, and for this reason it is arbitrarily neglected in this problem.

(*b*) In order to facilitate the study of this and other problems involving the properties of the catenary the writer has constructed the catenary charts which are appended, and which he hopes may be of service to others,


For values of L between those given, interpolate on lines radial from o on the right half of the sheet, and from k on the left half. The distances of the curves from the origins on any radial line, are directly proportional to L
CATENARY CHART
No 1
L = 10,000
L = 6,500
H
Dip
600 550 500 450 400 350 300 250 200 150 100 90 80 70 60 50 40 30 20 10 0
60,000 55,000 50,000 45,000 40,000 35,000 30,000 25,000 20,000 15,000 10,000 5,000

in the solution of similar problems. The method of computation is as follows:



w = Weight per unit length of line.

l = Length from lowest point to (x, y).

$L = 2l$ = Length between supports at equal elevation.

S = Span between supports at equal elevation.

H = Horizontal pull (same unit as w_1).

P = Pull at x, y in direction of line (same unit as w_1).

The equation of the catenary is—

$$(1)\quad y=\frac{a}{2}\left\{e^{\left(\frac{x}{a}\right)}+e^{-\left(\frac{x}{a}\right)}\right\}=a\cosh\left(\frac{x}{a}\right)$$

$$(2)\quad l=\frac{a}{2}\left\{e^{\left(\frac{x}{a}\right)}-e^{-\left(\frac{x}{a}\right)}\right\}=a\sinh\left(\frac{x}{a}\right)$$

Differentiating (1) gives—

$$(3)\quad \frac{dy}{dx}=\frac{1}{2}\left\{e^{\left(\frac{x}{a}\right)}-e^{-\left(\frac{x}{a}\right)}\right\}=\sinh\left(\frac{x}{a}\right)$$

But from the figure—

$$\frac{dy}{dx}=\frac{lw_1}{H},$$

whence—

$$\frac{l}{a}=\frac{lw_1}{H}, \text{ and } a=\frac{H}{w_1}.$$

Also from figure—

$$H=P\cos\sin^{-1}\left(\frac{dy}{dx}\right)=P\cos\sin^{-1}\left(\frac{lw_1}{P}\right)$$

EXAMPLE.

Let—

$2l = L = 1{,}000$ ft.

$P = 10{,}000$ lb.

$w_1 = 2$ lb. per ft. of line.

Then—

$$H=P\cos\sin^{-1}\left(\frac{lw_1}{P}\right)$$

$$=10{,}000\cos\sin^{-1}\left(\frac{500\times 2}{10{,}000}\right)=9{,}949.87 \text{ pounds.}$$

$$a=\frac{H}{w_1}=\frac{9{,}949.87}{2}=4{,}974.93 \text{ ft.}$$

and $\cosh\left(\frac{x}{a}\right)=1.005038.$

Whence—

$$\frac{x}{a}=0.1003353.$$

$$\sinh\left(\frac{x}{a}\right)=\frac{l}{a}=\frac{500}{4{,}974.93}=0.1005038.$$

$$S=2x=2a\frac{x}{a},$$

$= 2 \times 4{,}974.93 \times 1.003353 = 998.324$ ft.

$L - S = 1{,}000 - 998.324 = 1.676$ ft.

$$\text{Dip}=y-a=a\left[\cosh\left(\frac{x}{a}\right)-1\right]$$

$= 4{,}974.93 \times 0.05038 = 25.064$ ft.

(c)—

$H = 19{,}000$ lb.

Dip = 35 ft., of which 15 ft. are in air, and 20 ft. are in water.

$w_1 = 6.25$ lb. per ft. in air.

$w_1 = 6.25 \times 4/5 = 5$ lb. per ft. in water.

$$\frac{H}{w_1} \text{ in water} = \frac{19{,}000}{5} = 3{,}800.$$

The length of line submerged may be found on Catenary Chart No. 1 by locating the point a (dip = 20 and $\frac{H}{w_1} = 3{,}800$) and interpolating on the line oz drawn through the point a. More accurate results would be obtained by taking 1/10 ft. for the unit of length, thus:—w_1 becomes 0.5 lb. per tenth ft., the dip is expressed as—

$$20 \times 10 = 200.$$

and—

$$\frac{H}{w_1}=\frac{19{,}000}{0.5}=38{,}000.$$

Locating the point a' (dip = 200 and $\frac{H}{w_1} = 38{,}000$) and interpolating on the line Kz' drawn through a' the length L is found to be 7,810 tenths ft. or 781 ft. The "length minus span" is found on Catenary Chart No. 2, point a or a' to be 1.37 ft.

Now 781 ft. of line in water is about equivalent in weight to—

$$781 \times \frac{4}{5} = 625 \text{ ft. in air,}$$

and 625 ft. of line in air with—

$$\frac{H}{w_1}=\frac{19{,}000}{6.25}=3{,}040,$$

or—

$$\frac{19{,}000}{0.625}=30{,}400,$$

would have a dip (see Catenary Chart No. 1, point b') of $\frac{160}{10} = 16$ ft.

The length minus span (Catenary Chart No. 2, point b') is 1.1 ft.

The total length out of water to give—

$$16 + 15 = 31 \text{ ft. dip}$$

is (Chart No. 1, point c') 871 ft.

The corresponding length minus span is (Chart No. 2, point c') 2.95 ft.

The length out of water for the conditions described will be 871 — 625 = 246 ft. The length minus span for this line will be

$$2.95 - 1.1 = 1.85 \text{ ft.};$$

$$\frac{P}{w_1} = 3{,}070;$$

$$P = 3{,}070 \times 6.25 = 19{,}200,$$

(point c', Charts No. 3 and No. 4).

The total length of the line in and above the water will be

$$781 + 246 = 1{,}027 \text{ ft.}$$

The total length minus span = 1.37 + 1.85 = 3.22 ft.

If we had assumed the whole line to be out of water with—

$$\frac{H}{w_1}=\frac{19{,}000}{6.25}=3{,}040,$$

and a dip of 35 ft. L would have been 925 and length minus span = 3.55 ft.

If we had assumed the whole line to be submerged, *i. e.,*

$$\frac{H}{w_1}=\frac{19{,}000}{5}=3{,}800,$$

then for a dip of 35 ft., $L = 1{,}034$, and length minus span = 3.15 ft.

If supports are chosen at unequal elevation the length of the line is the mean between that for both supports at the lower elevation, and that for both supports at the upper elevation, *not that for both supports at the mean elevation.*

(c1)—

When $H = 39\frac{1}{2}$ tons or 79,000 lb.,

$$\frac{H}{w_1} \text{ in air} = \frac{79{,}000}{6.25} = 12{,}640$$

Dip = about $10\frac{1}{4}$ ft. (Chart No. 1, point d).

Length minus span = 0.3 ft. (Chart No. 2, point d.)

P and H are so nearly equal that they may be used here interchangeably. Stretch due to added pull is then about

$$\frac{79{,}000 - 19{,}000}{160{,}000} \times 0.0058 \times 1{,}027$$

$$= 2.23 \text{ ft.}$$

(See Note c.)

(c2)—

When $H = 83\frac{1}{2}$ tons or 167,000 lb.,

$$\frac{H}{w_1} \text{ in air} = \frac{167{,}000}{6.25} = 26{,}700.$$

Dip is about 5 ft. (Chart No. 1, point e).

Length minus span about 0.075 (Chart No. 2, point e).

Stretch due to added pull is—

$$\frac{167{,}000 - 79{,}000}{160{,}000} \times 0.0058 \times 1{,}027$$

$$= 3.275 \text{ ft.}$$

(c3)—

When $H = 26{,}600$,

$$\frac{H}{w_1} \text{ in water} = \frac{26{,}600}{0.5} = 53{,}200.$$

The dip for a length of 662 ft. is 10.3 ft.

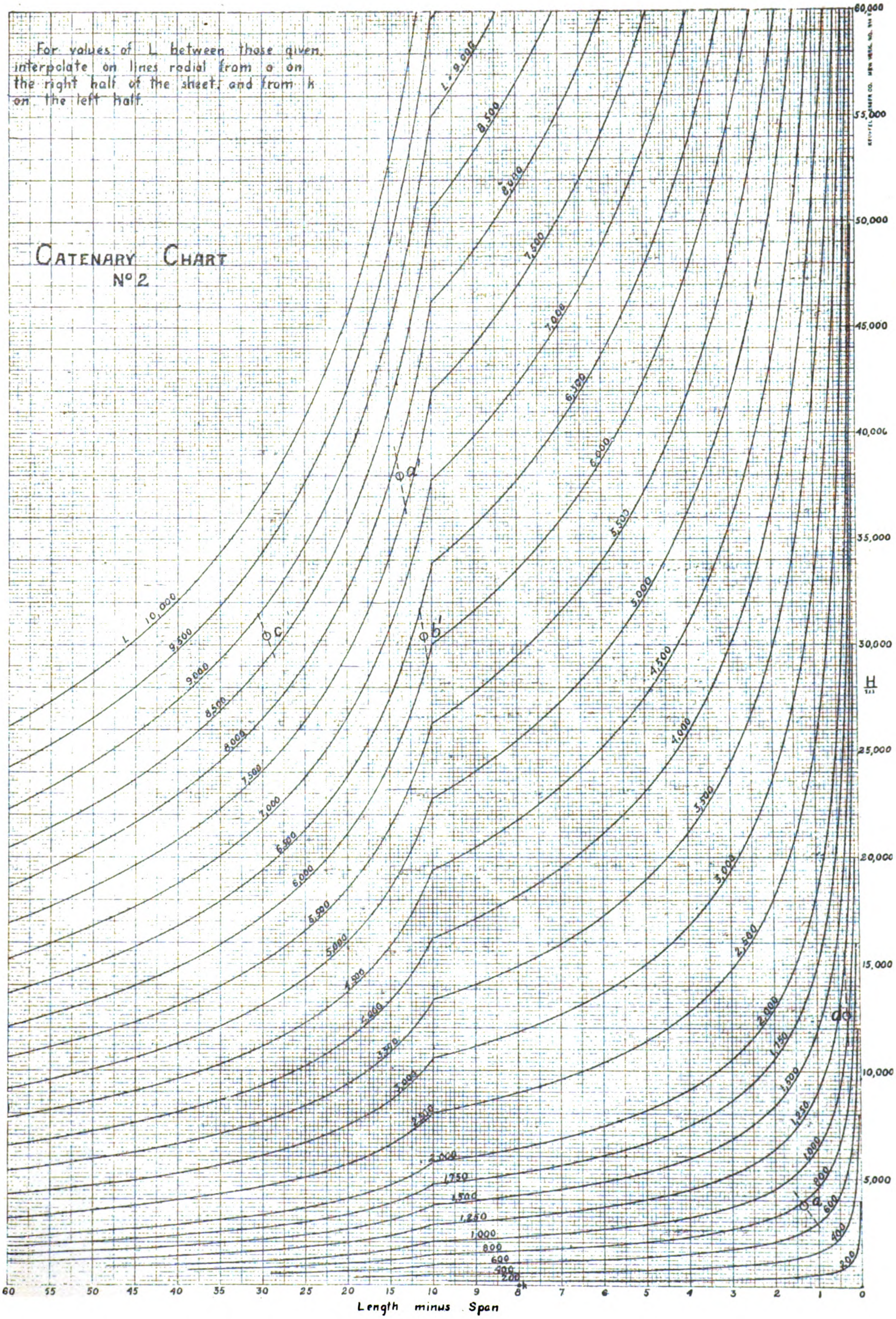
$$\frac{H}{w_1} \text{ in air} = \frac{26{,}600}{0.625} = 42{,}600.$$

The dip for 364 ft. (182 ft. in each end of a length of 893 ft.) is 15 ft. of the 23.2 ft. for the total dip of the 893 ft. length in air.

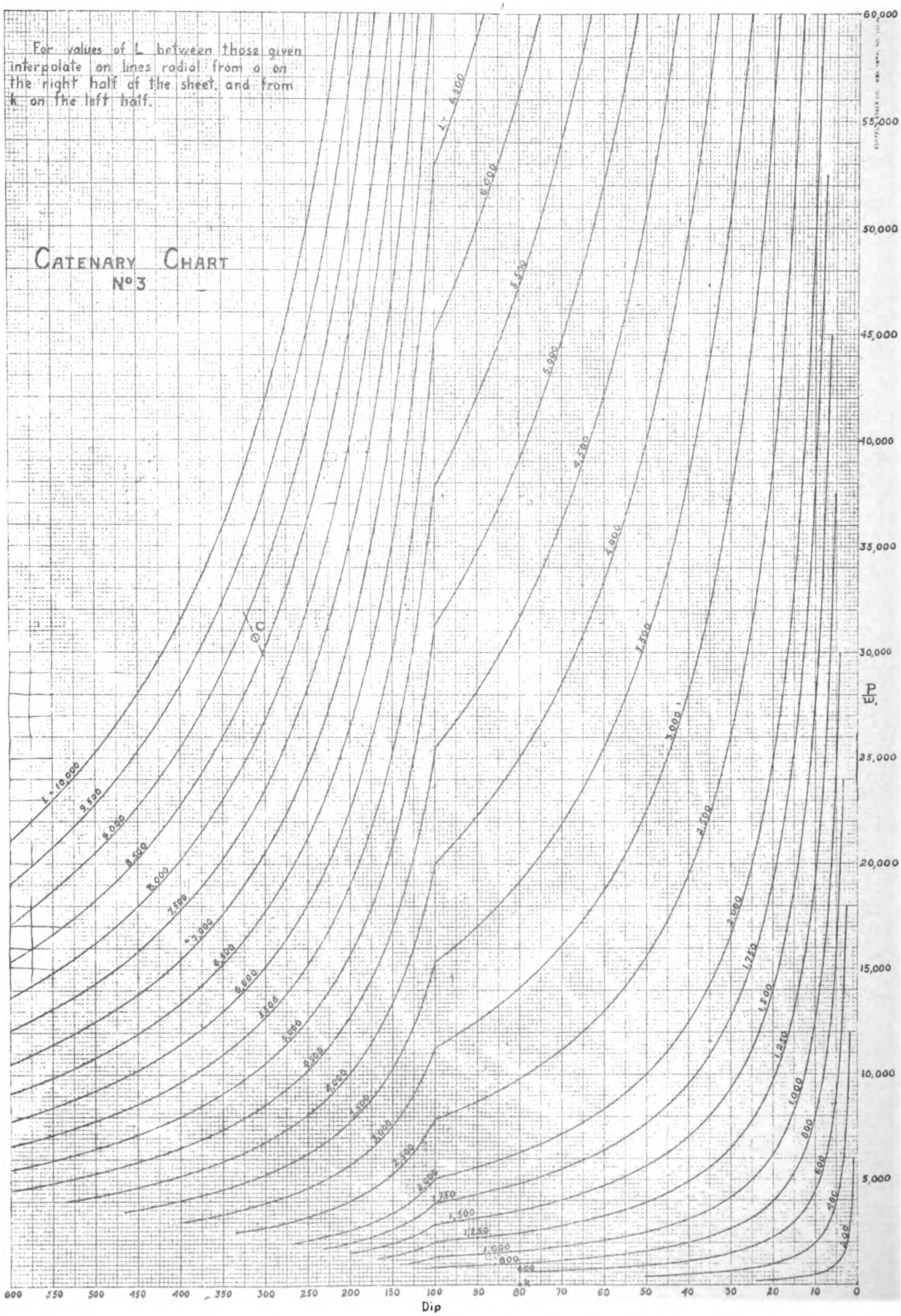
Whence the dip for—

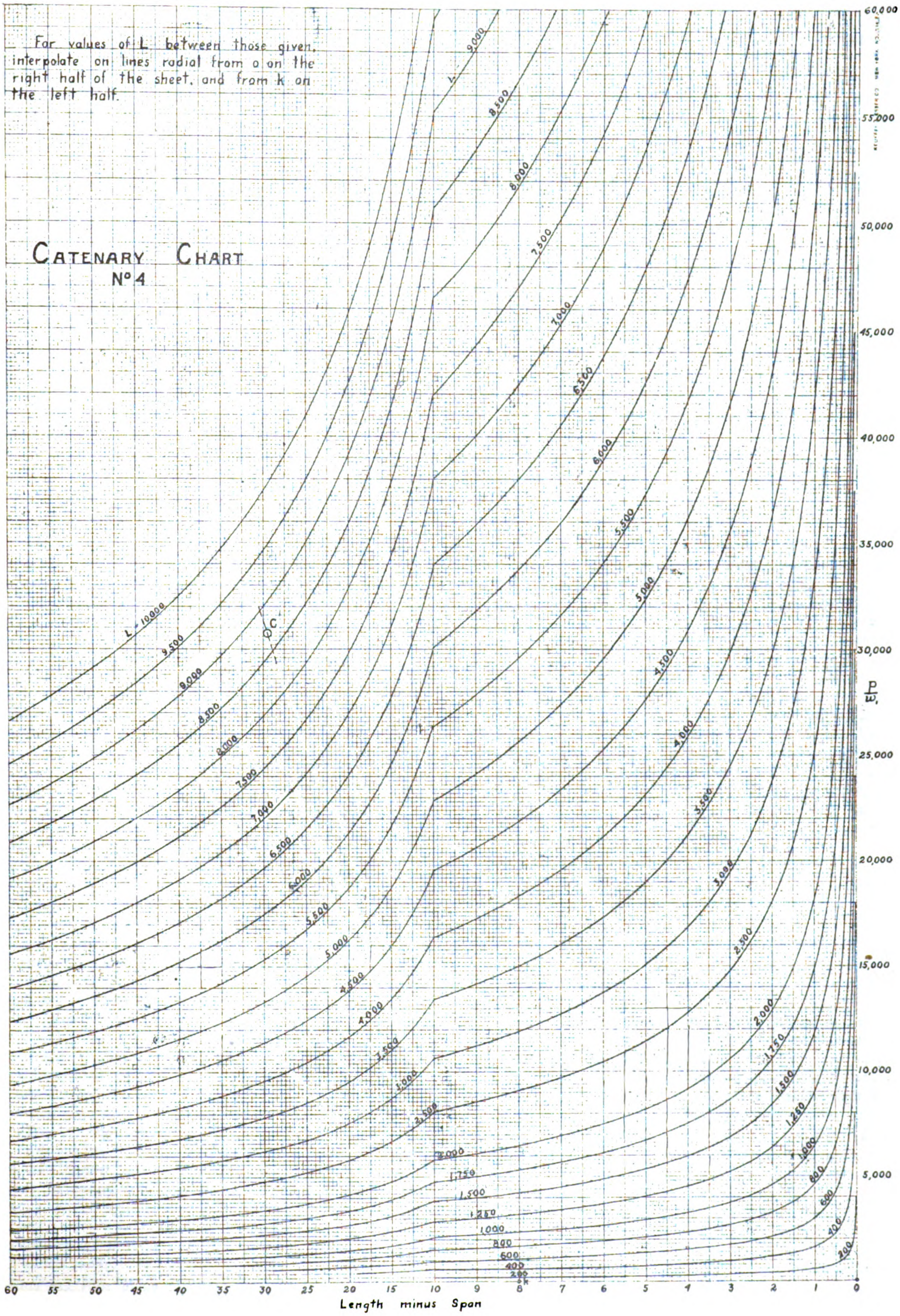
364 ft. in air is....	15.0 ft.
662 ft. in water is..	10.3 ft.
And total dip for 1,026 ft. in air and water is.....	25.3 ft.

The stretch due to the added load is



For values of L between those given, interpolate on lines radial from o on the right half of the sheet, and from k on the left half.
CATENARY CHART
No. 2
Length minus Span
H


For values of L between those given interpolate on lines radial from o on the right half of the sheet, and from k on the left half.
CATENARY CHART
No 3
Dip
P/w


For values of L between those given, interpolate on lines radial from o on the right half of the sheet, and from k on the left half.
CATENARY CHART
No 4
L = 10,000
9,500
9,000
8,500
8,000
7,500
7,000
6,500
6,000
5,500
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,750
1,500
1,250
1,000
800
600
400
200
C
60,000
55,000
50,000
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
60 55 50 45 40 35 30 25 20 15 10 9 8 7 6 5 4 3 2 1 0
Length minus Span

$$\frac{26,600 - 19,000}{160,000} \times 0.0058 \times 1,027 = 0.283 \text{ ft.}$$

L-S for 893 ft. in air.... = 1.62 ft.
L-S for 529 ft. in air.... = 0.34 ft.

L-S for 364 ft. in air.... = 1.28 ft.
L-S for 662 ft. in water. = 0.426 ft.

Total L-S for line in air and water .... = 1.71 ft.

Increase of span due to take-up of dip = 3.22 — 1.71 = 1.51 ft.

(*d*) A continuous uniform, net additional force, such as is assumed would not be likely to occur in practice. The assumption is made to simplify the problem and is sufficient to illustrate the principle involved.

(*e*) The writer made some attempt to obtain data concerning the stretch from several manufacturers and importers of wire and manila rope. All hesitated about giving out data on the ground that the stretch is an exceedingly variable quantity depending in part on the lay and condition of the line.

Inasmuch as the calculation necessarily involves the stretch of the line the writer obtained samples and made some rough tests to obtain figures with which to work.

The wire line was tested for stretch up to a little over half the elastic limit and the extension was at the rate of about 58/100 per cent of the length for a load equal to the elastic limit. This was after the first or second application of the load when what appeared to be the permanent stretch had been set in the line. The stretch with the first application of the load was more than twice this amount.

The stretch of the manila line varied considerably in the different samples, but may be taken at the rate of about 10 times that of the wire line when the former has a tabulated ultimate strength equal to the tabulated elastic limit of the latter. The stretch with the first loading was in one case over four times that resulting from the later equal loadings.

While no claim is made to absolute accuracy in these tests, which had to be made in some haste, the results are not in error to any such extent as would impair their value for the use to which they are put in this paper.

(*f*)—

t = time in seconds.

w = weight of one vessel in net tons.

s = distance ft. through which force acts on each vessel = ½ total motion apart.

F = average accelerating force in net tons.

g = acceleration due to gravity = 32.2 ft. per second.[2]

$$t = \sqrt{\frac{2ws}{Fg}}.$$

Substituting values for wire line:—

$$t = \sqrt{\frac{2 \times 15,000 \times \frac{5.15}{2}}{15 \times 32.2}}$$

$$= \sqrt{160} = 12.6891 \text{ seconds.}$$

Same for manila line.

$$t = \sqrt{\frac{2 \times 15,000 \times \frac{25.45}{2}}{15 \times 32.2}}$$

$$= \sqrt{791} = 28.1297 \text{ seconds.}$$

(*g*) The drum dimensions are a considerable factor in determining the weight and cost of the machine, and the space occupied.

Discussion on Mr. Kemble's Paper.

Robert S. Riley.—So little is known of the scientific side of towing problems that Mr. Kemble's paper should be very valuable in drawing attention to something beyond what is known among practical towing men. This paper shows very careful preparation and intimate technical knowledge of the subject, and its writer deserves great credit for the care he has taken in reducing to figures some of the hitherto unknown quantities regarding the sag of the line.

Of course the great limitation of this paper is that the figures are all relative, and that the time element is missing. Practical towing men are apt to say that such data is of little real service to them. They say it is all very well to figure out how much the line will straighten due to the increased pull, and how much extra it will sag due to a slackening on the pull, but no one knows anything about how much that pull is going to be increased or decreased, what is the use of knowing what will happen provided the changes were thus and so. It reminds one somewhat of the comment made by the Yankee on hearing the pyramids praised as a wonderful achievement; all he said was, "But there is no demand for pyramids where I come from."

The average tow-boat or barge owner doesn't care much whether his line sags 1/10 of a ft. or 2 3/10 ft. All he cares about is whether or not it will stand the strain under his conditions and he looks to his captain to keep it as taut as possible and to get it in smartly in case he has to slow down.

Of course it is true that there are many shoals, both in the lake and coast channels where the sag should not exceed a given amount, and this must be governed by the practical common sense of the captain. In towing over shoals the water is apt to be smooth and he does not require so much line so the sag is practically dependent on the way he handles his tug. He knows that it will sag if he is obliged to slow down and there is very little chance of referring to catenary curves when such conditions arise.

Fortunately the towing machine has abundantly proven its value in preventing the breakage of lines. We know that it pays out until the increased strain is counterbalanced by the compression of the steam in the cylinders, and that it makes an ideal machine for rough weather towing. It would seem, however, that the service that is coming to be most appreciated is in the reeling of the line without manual labor. Of course the towing machine is, and always will be, a big factor in saving the breakage of lines, but the present labor conditions seem to show that its greatest value is in the saving of labor. This applies particularly to smaller tugs working in and out of harbors where the lines have to be handled frequently. The machine does not belong to the union, it never talks back and will work any hour of day or night. The average deck hand much prefers to handle a lever and watch the line come in of itself rather than show what he can do in the way of hauling and coiling it himself. It is also a great factor in the manipulation of the tows to be able to handle the line quickly while under way, instead of being obliged to drift idly while the men are hauling in the line by hand.

In this connection it will no doubt interest the members of the society to know that manual labor has been still further eliminated by the introduction of an automatic winding device. The towing machines built by the American Ship Windlass Co. are now almost invariably equipped with a pair of moving guide rolls which automatically guide the lines onto the drum in even layers. They follow along the drum until one layer is complete, then when the line reaches the flange, automatically reverse their direction so as to lay the next layer evenly on top of the one just laid. They do so independently of the action of the towing machine, no matter how quickly it may be reversed during severe service. The proper laying of the cable on the drum, besides eliminating the manual labor required otherwise, also serves to prevent the line climbing up on one side and injuring itself by scraping and jumping into place after it has mounted during the process of reeling in.

These automatic guide rolls are con-

trolled by a double threaded shaft which is revolved by chain connection and from the main drum shaft. The guide roll carriage supports the double threaded shaft as well as two horizontal guide stanchions, and carries a horseshoe-shaped nut which fits into the grooves of the double threaded shaft. This nut swivels on an extension at the toe of the horseshoe and after following along the thread leading in one direction until it reaches the end, it is automatically and positively guided so that it turns and leads back in the opposite thread.

These winding devices have been fitted with great success to all sized towing machines from the largest to the smallest.

It is made so strong by means of diagonal stays that it will resist the breaking strain of the line during a pull athwartship. This winding device allows the omission of the stern bitts that were formerly considered necessary at the after end of the tug boat. The line may lead back from the guide rolls in any direction required without interfering in any way with this even winding on the drum. The advantage of omitting the stern bitts on tug boats is obvious, it not only decreases the weight but also allows the line to lead from a point further forward than would otherwise be the case. This is considered a strong point among tug boat men, especially when required to maneuver in crowded waters.

This device has made the use of the towing machine possible on tugs that were formerly considered too short to afford the necessary space abaft the house. Machines of the type shown have been fitted on tug boats less than 100 ft. long, simply by the removal of the after towing bitts and the location of the machine in their place.

Some attention has been devoted to the advantages of the spring set brake. This advantage, however, is apt to be more theoretical than practical for the fact is that very few deck hands are capable of using any discretion in their tightening on the brake wheel, they simply screw it down hard until they can get no more, so it makes no difference whether there is a spring or not, it is sure to be set up so tight that there is no chance to utilize the theoretical advantages of such a spring.

Another point that has been mentioned is that the towing machines with which the writer of this paper is familiar have adopted a quick opening valve, and such a quick opening prevents the paying out of an excessive length of line when the vessels surge or rear. The theory as set forth in the paper is, that the quick admission of steam serves to increase the pressure on the steam cushions quickly and thus check the paying out of the line.

Against this theory, however, there looms up an interesting fact that the resistance of the towing machine to paying out line is not due primarily to the admission of more steam but rather to the compression of steam already in the cylinders. Many years of observation and experience with towing machines shows that the original type of automatic valve gear which opens gradually as the machine pays out, serves to check the line fully as quickly as is desirable.

It is evident that the rapid consumption of steam in the towing machine occurs only when it is recovering line, for it is then an ordinary steam winch. When standing still, holding the line by the steam compression in the cylinders, the consumption is only that required to make up the loss due to condensation and leakage. When paying out line the leakage is naturally increased, and there may be a slight loss due to clearance volume in the cylinder.

But it has no chance to take in steam in large quantities for it is theoretically pumping back into the boilers. The greater importance of this compressing of steam already in the cylinders as compared with the importance of admitting more steam is proven by a practical comparison of machines in service. The quicker opening valve seems to have no noticeable effect in this connection, probably because at the time of greatest resistance the fresh steam cannot overcome the compression due to paying out. This very feature is shown and mentioned in the article under discussion where the steam pressure in one of the paying out cards shows a higher pressure in the cylinder than that used in the admission pipe. This alone would seem to prove that the resistance to paying out was due mostly to the compression mentioned and not to the admission of more steam. The quick acting automatic valve mentioned is very ingenious and clever but seems also to be open to the same remark that the Yankee made about pyramids.

No doubt further light can be thrown on this by a series of cards which will bring out the element of time; it is to be hoped that the society may soon have further data in this connection.

Mr. Penton's Written Discussion.

Henry Penton.—The gist of this paper is in the proper length of hawser for best results in towing and this is, practically speaking, all-important. Every unnecessary foot of hawser is an item of expense, in cost and in added resistance.

Frequent failures of towing hawsers, generally at a point some distance from the machine or towing hook, have led to the conclusion that they are mostly attributable to contact with channel bottoms, and this to consideration of the dip of hawser under conditions which are sufficiently well known. But information on the subject apparently does not exist; at least I have failed to find any. Mr. Kemble has gone at the subject in a thorough and painstaking way and his investigations bear out in every respect the conclusions previously drawn. He is unquestionably right in his premise that the length of wire hawser used is due partly to the length previously found advisable with manila to provide sufficient elasticity, and partly to the comparative lack of this in the wire. I am confident that the view so commonly held —that a long hawser makes for better steering—is erroneous, for the reason that the pull on the barge, both as to direction and amount, is entirely independent of length of line; and it is the stern of the ship which swings under rudder action and not her head; and this is true for all ordinary conditions under way, and so long as the barge is clear of the race of the propeller, the shorter the line the better. This refers to normal good weather. As to the propeller race, I do not believe that it is perceptible 300 ft. astern, for the reason that I have repeatedly towed a log from the taffrail on 50 to 60 fathoms of line without perceptibly affecting its reading as compared with towing from a boom under identical conditions. It is a common occurrence to see a ship slewing in a seaway and her log trailing in and out of her wake. Mr. Kemble suggested a constant for length of line, but I think his figure is too large and that 450 would be ample for all conditions. Even in bad weather, the length of line can be carried too far, as the greater the length and dip, the greater the towing resistance, the more readily the machine is overhauled and the greater the labor on the machine in recovery.

The indicator cards shown are unique and interesting. If any one has any doubt as to the amount of labor the author has spent on this paper, let him look up the literature on the subject and I think he will agree that Mr. Kemble has supplied

in concrete form a vast amount of valuable information.

With the charts he has worked out the dip of any line of given length is shown, the approximate pull being known, or vice versa. The ordinary thrust of any steamer under normal conditions is easily calculated and with the exercise of a little discretion the master has always at hand a ready check on the length of line best suited to existing conditions. It is needless to point out that a dip great enough to foul bottom on the Grand Banks in 70 fathoms is accomplishing nothing except adding enormously to towing resistance.

Closing Discussion.

T. S. Kemble: Mr. Riley states that the resistance of towing machines to paying out line is not due primarily to the admission of more steam but rather to the compression of steam already in the cylinders.

I have made some study of this subject and believe that we may accept his explanation as applying to that type of machine which is equipped with a slow opening automatic valve, but the indicator cards on Plate 1 and Plate 2 show clearly that it does not apply to machines with a quick opening valve, although the machine from which those cards were taken has not so swift a valve opening as is now used on this class of machines. In one set of cards, taken with a heavy head sea, I found a pressure in the cylinder a trifle higher than that reported in the admission pipe, but this was the only case in a long series of rolls taken on various occasions under all sorts of weather conditions. The general operation is shown by the indicator cards to be due to admission pipe pressure.

Mr. Riley's theory of operation implies the assumption that the machine has stopped winding in just *before* one crank reached dead center. We would have one cylinder full of steam and the other cylinder half full, and if for the sake of concrete illustration we assume a volume in the clearances and passages back to the automatic valve equal to another half cylinder volume, we would have two full cylinder volumes of steam. It will also simplify the illustration if we consider the steam as a perfect gas in which the product of pressure and volume is constant and neglect all consideration of initial condensation, wire drawing, etc., which are aside from the point under discussion.

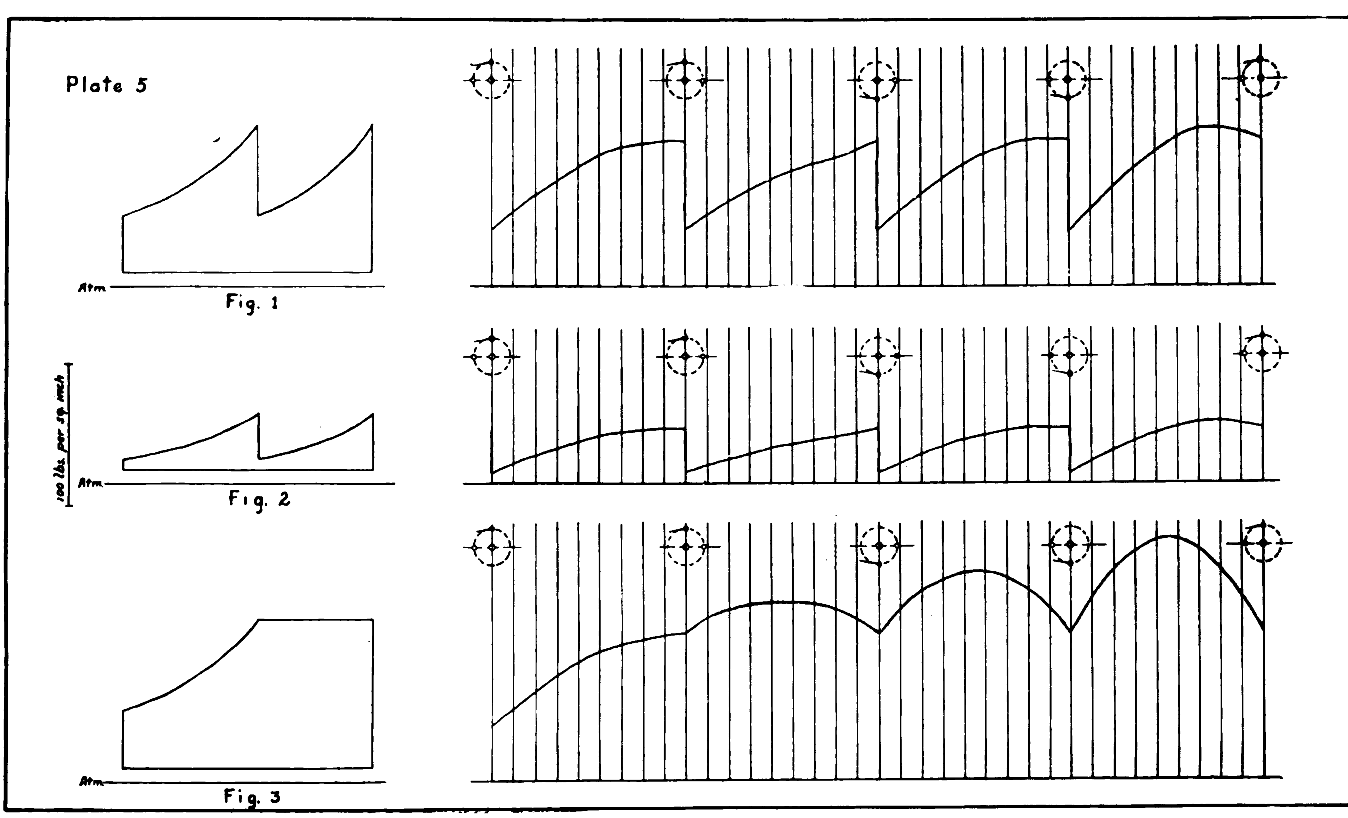
The overhauling of the engine for nearly half a stroke would force all the steam into the clearances and passages and the half of one cylinder, cutting the steam space in half and doubling the pressure which was present at the beginning of the operation. The steam then re-expands to the original pressure and repeats the cycle. If, however, the machine should stop just *after* one crank had passed the center instead of just before, there would be present at the beginning only one full cylinder volume. As soon as the machine began to be overhauled this crank would re-cross the center, the steam space would be doubled and the steam pressure cut to half that present when holding the load. The next half stroke would compress this steam to the original pressure and re-expand it to one-half again.

The action when the machine began paying out from any position other than those described would be a compromise between the two.

I have prepared diagrams illustrating this action. The steam pressure holding the load is taken at 65 lb. absolute, the back pressure at 25 lb. absolute and the pipe line pressure at 130 lb. absolute. Fig. 1 is a conventional card illustrating the changes in pressure when the machine is overhauled from the position first described, in which we have two full cylinder volumes at the beginning. Fig. 2 is a similar card illustrating the changes in pressure when there is only one full cylinder volume at the beginning.

Fig. 3 is a similar card illustrating the changes in pressure when there are two cylinder volumes of steam present at the beginning, and when the valve opens very rapidly, giving a very large area through which the steam may enter.

In some machines the automatic valve is now opened to give an area equal to the steam pipe area in two strokes of the piston, and as the first motion of the machine is relatively slow, the pressure in the cylinders is almost if not quite as high immediately after the first half stroke as it is with the valve wide open.



At the right of each card is shown the corresponding tangential pressure for one complete revolution derived in exactly the same manner as those shown on Plate 1.

It is needless to state that initial condensation, re-evaporation, wire drawing, etc., all combine to make these cards unattainable in practice, but they are comparative and illustrate very clearly the principles on which these two types of machines operate. It will be seen that in the machine with the slow opening valve while the momentary rise in pressure may be as rapid as in the other type, still the pressure is not sustained, but rises and falls in swift pulsations and does not, even with the most favorable assumptions, give as great an average resistance to paying out until after a considerable amount of line has been run out. Experience and theoretical investigation agree that the sooner the resistance is put on and the steadier it is maintained, the better is the action of the machine. The vessels actually do separate less, less steam is consumed in returning them to their normal positions, and the danger of accident due to collision or grounding is reduced to a minimum.

"Shallow Draught River Steamers."

The first paper read on Saturday morning was Mr. Charles Ward's paper on "Shallow Draught River Steamers." The variety and extent of the illustrations make it impossible to reproduce this paper in full; but it was one of the most interesting and most important submitted, and the Transactions containing it will doubtless be frequently consulted, so little authentic data having hitherto been published on this subject. The salient features of Mr. Ward's paper will be published in the August MARINE REVIEW.

Discussion on Mr. Ward's Paper.

Frank E. Kirby—Personally I greatly appreciate this paper, and I can also appreciate the difficulty of preparing it; and I believe that there is a great future for steamboating on the Mississippi and tributary waters. The reason I say I personally appreciate it, some years ago I was asked to look over some plans and specifications for a river ferry boat at St. Louis, and along my lines of experience I could not subscribe to their plans and the company said they were then in greater difficulty than they were before; so I was asked by them to prepare plans for a ferry boat which is now in operation at St. Louis, having a length of 170 ft., 76 ft. wide over the guards, 48 ft. hull, and has side wheels. The wheels are driven by independent compound engines located in the hold. The object of the broad design is to afford all the deck space possible for wagons. The engine is operated from the middle of the ship. The engines both proved very satisfactory and the company now are in the market for two duplicate boats using the same type of engines and boilers with a somewhat larger hold. Mr. Ward did not tell you some things about the engines in these river boats. When I went to St. Louis to look into the matter of the ferry boat I remember they had in service what is called there a boot jack model boat; that is, a boat with a double stern and a wheel located between them. Mr. Ward did not tell in his paper all about the lever engine commonly used on the western rivers, that is, the single engines. When backing them they commonly made up the exhaust and steam lead with—what shall I say—a club. A hickory stick about 2 in. sq. hung from a peg from the ceiling of the engine room. The engineer thrust this between the jaws of the wipers and the lever when backing. This operation restored the necessary lead, which had been lost by using the go-ahead eccentric for backing; the hook of the eccentric rod being lifted off the go-ahead pin on the bottom end of a double ended lever fixed to a rocking shaft and hooked on to the top pin. I asked the engineer why he did that. He evidently did not understand the philosophy of it, for he said it was because they always did it that way. The paper is very valuable and there has been a great deal of care in working out these details.

Stevenson Taylor.—I believe the title of this paper should have been "Shallow Draught Western River Steamers." There is a difference of opinion as to what constitutes shallow water. The Detroit river might, for instance, be considered a shallow stream. I think this paper proves the necessity of looking upon the habit and custom of a place with sympathy rather than criticism. There is a great deal of information in this paper which has never been presented to the society before and the Transactions containing it will be consulted many times in the future. I move a vote of thanks to Mr. Ward.

President Bowles.—It is proper to comment upon the great care and labor which Mr. Ward has exercised in the preparation of this paper. It certainly shows an enormous field for the engineers of this country to develop. It also emphasizes the great difficulties which engineers have in putting in practice obvious improvements from the lack of education of those who are obliged to manage these businesses, which brings us directly to the problem that is confronting us of industrial education in the United States, a matter which would go further to extend our opportunities than almost any other movement of today.

A vote of thanks was tendered to Mr. Ward.

Alexander E. Brown, of the Brown Hoisting Machinery Co., had undertaken to prepare a paper on "Material Handling Arrangements for Vessels on the Great Lakes," but illness prevented him from finishing it. R. B. Sheridan presented Mr. Brown's regrets in person and the hope was expressed that Mr. Brown might be able to prepare the paper for the fall meeting.

The Strength of Knees and Brackets on Beams and Stiffeners.

Prof. H. C. Sadler then read H. R. Hunt's paper on "The Strength of Knees and Brackets on Beams and Stiffeners," as follows:

An examination of the midship sections of various United States naval vessels by the author showed that, in general, the depth and riveting of knees and brackets at the ends of beams and stiffeners are regulated by the depths of the beams and stiffeners, although the shapes, weights, and strength vary to a considerable extent. It was therefore thought interesting to investigate the strength of the knees and brackets at the ends of the various beams and stiffeners.

Since the case of stiffeners and beams with brackets at the ends is like that of beams with knees at the ends, we will consider in this article the case of beams supported by knees at the ends.

The beams and knees investigated are given in Table I on Plate 1 and by sketches on Plate 2. The riveting in the beam knees of the Olympia, Nashville and Dubuque was assumed from the practice found in the other ships and some of our leading shipyards for the same sized beams. In all other respects, the data is taken from work as actually installed in the ships named.

In general, this table shows, in columns 1 to 7, that the practice in United States naval vessels is to make the depths of knees three times the depths of beams, and to use one ¾-in. rivet in the knees per inch depth of the beams. The exceptions to this statement are the 6-in. beam of the

TABLE I
COMPARISON OF STRENGTH OF BEAMS WITH STRENGTH OF KNEES AND BRACKETS, TAKEN FROM PRACTICE.

NAME OF SHIP	BEAM: TYPE OF SECTION	BEAM: SIZE	THICKNESS	DEPTH OF KNEE OR BRACKET	RATIO DEPTH KNEE / DEPTH BEAM	NO. OF ¾" RIVETS AS IN U.S. NAVY	FIG. NO.	RIVETS REQUIRED BY LLOYD'S: NO.	RIVETS REQUIRED BY LLOYD'S: DIA	LOAD TO SHEAR-TONS: BEAM	LOAD TO SHEAR-TONS: RIVETS U.S.N.	LOAD TO SHEAR-TONS: RIVETS LLOYD'S	RATIO = SHEAR RIVETS / SHEAR BEAM: U.S.N.	RATIO: LLOYD'S	BENDING MOMENT TO PRODUCE RUPTURE IN FT. TONS: BENDING BEAM	SHEARING RIVETS U.S.N.	SHEARING RIVETS LLOYDS	CRUSHING IN FRONT OF RIVETS U.S.N.	CRUSHING IN FRONT OF RIVETS LLOYDS	RATIO RIVETING MOMENT / BEAM MOMENT: SHEARING U.S.N.	SHEARING LLOYD'S	CRUSHING U.S.N.	CRUSHING LLOYD'S
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
*OLYMPIA	[	10"×3½"×26.5#	31/64	30"	3	10	1	7	7/8"	164.8	98.6	94.0	.60	.57	535	559	571	683	598	1.05	1.07	1.28	1.12
VERMONT	[	10"×3⅜"×3⅜"×21.8#	3/8"	30"	3	10	1	7	7/8"	136.4	98.6	94.0	.72	.70	453	559	571	683	598	1.23	1.26	1.57	1.37
RHODE ISLAND	[	9"×3½"×21.8#	7/16"	27"	3	10	2	6	7/8"	134.6	98.6	80.6	.74	.60	375	498	473	710	495	1.33	1.26	1.89	1.32
RHODE ISLAND	[	8"×3½"×19.23#	13/32	24"	3	8	3	6	7/8"	120.1	78.8	80.6	.66	.67	290	396	406	525	425	1.37	1.40	1.81	1.47
RHODE ISLAND	[	7"×3"×18.25#	7/16"	21"	3	7	4	5	7/8"	111.5	69.0	67.2	.62	.60	244	294	312	360	327	1.21	1.28	1.48	1.34
VERMONT	Γ	7"×3½"×15#	7/16"	21"	3	7	4	5	7/8"	90.8	69.0	67.2	.76	.74	133	294	312	360	327	2.21	2.35	2.71	2.46
VERMONT	[	6"×3½"×3½"×15#	0.35	18"	3	6	5	6	3/4"	93.3	59.1	59.1	.63	.63	196	224	224	273	273	1.14	1.14	1.39	1.39
SALEM	[	6"×1.72"×1.72"×8#	0.20	18"	3	7	6	5	3/4"	50.2	69.0	49.3	1.37	.98	106	250	191	163	125	2.36	1.80	1.62	1.18
*NASHVILLE	[	6"×3"×13.76#	3/8"	18"	3	6	5	5	3/4"	83.9	59.1	49.3	.70	.59	158	224	191	273	234	1.42	1.21	1.73	1.48
RHODE ISLAND	[	6"×3"×12.3#	5/16"	18"	3	6	5	5	3/4"	76.8	59.1	49.3	.77	.64	149	224	191	273	234	1.50	1.28	1.83	1.57
RHODE ISLAND	Γ	6"×3½"×13.5#	7/16"	18"	3	6	5	5	3/4"	81.2	59.1	49.3	.73	.61	101	224	191	273	234	2.21	1.89	2.70	2.32
VERMONT	Γ	5"×3"×9.8#	3/8"	18"	3 6/10	6	7	5	3/4"	57.6	59.1	49.3	1.03	.85	60	224	191	273	234	3.77	3.18	4.55	3.90
DES MOINES	Γ	4½"×3"×9.1#	3/8"	12"	2 2/3	4	8	4	3/4"	53.3	39.7	39.7	.75	.75	49	99	99	121	121	2.02	2.02	2.47	2.47
*DUBUQUE	Γ	4"×3"×8.5#	3/8"	10"	2 1/2	4	9	4	3/4"	49.1	39.7	39.7	.81	.81	39	78	78	90	90	2.00	2.00	2.31	2.31
*DUBUQUE	Γ	3½"×3"×6.6#	5/16	10"	2 6/7	4	9	4	3/4"	38.6	39.7	39.7	1.03	1.03	26	78	78	90	90	3.00	3.00	3.46	3.46

* NUMBER OF RIVETS ASSUMED FROM PRACTICE ON U.S. NAVAL VESSELS

Salem and the 5-in. beam of the Vermont. For comparison, the number and size of rivets required by Lloyds Rules for the same knees are given in columns 8 and 9, and are determined entirely from the depths of the knees.

The strength of knees at the ends of a beam depends to a great extent on the depth and the thickness of the knees and the number of rivets placed therein, and must be considered with reference to the strength of the beams supported.

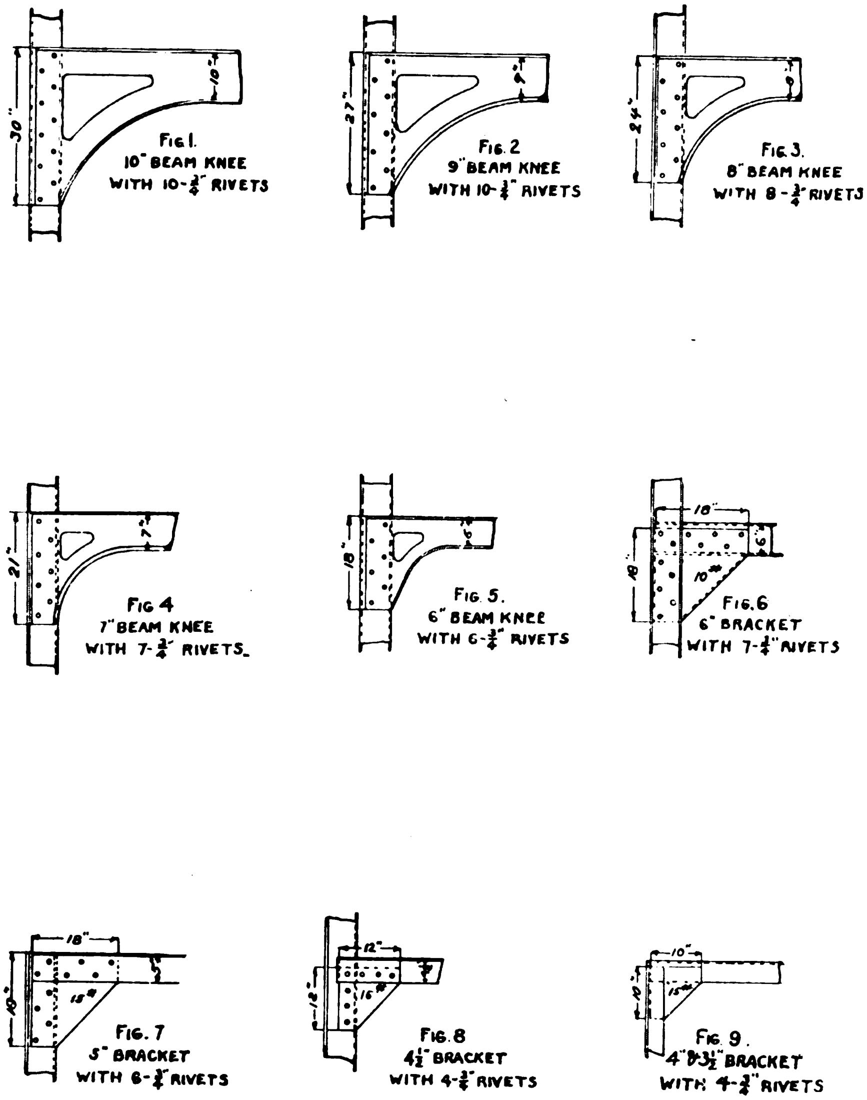
The rivets and plating in the knees must be able to resist the shearing and crushing forces caused by loading the beam to the point of rupture. Rupture by shearing or crushing may be caused either by the concentration of a load at one end of the beam, or by the combination of the forces due to loading the beam between the supporting knees.

If the load is concentrated at the end of a beam, the shearing and crushing forces are uniformly distributed among the rivets, and are vertical. If the beam is loaded between the supports, the shearing and crushing forces are the resultants of the vertical forces due to the load, which are uniformly distributed among the rivets, and the horizontal forces due to the bending moment which are distributed among the rivets in proportion to their distance from a pole through the center of gravity of the area of all the rivets,

TABLE II
COMPARISON OF STRENGTH OF BEAMS WITH STRENGTH OF KNEES AND BRACKETS RECOMMENDED FOR USE

BEAM: TYPE OF SECTION	BEAM: SIZE	THICKNESS	DEPTH OF KNEE OR BRACKET	RATIO DEPTH KNEE / DEPTH BEAM	NO. OF ¾" RIVETS	FIG. NO.	LOAD TO SHEAR TONS: BEAM	LOAD TO SHEAR TONS: RIVETS	RATIO SHEAR RIVETS / SHEAR BEAM	BENDING MOMENT TO PRODUCE RUPTURE-FT TONS: BENDING BEAM	SHEARING RIVETS	CRUSHING IN FRONT OF RIVETS.	RATIO RIVET MOM / BEAM MOM: SHEARING	CRUSHING
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
[	10"×3½"×26.8#	31/64"	33"	3.3	11	—	164.8	108.5	.66	535	661	751	1.24	1.40
[	10"×3⅜"×3⅜"×21.8#	3/8"	30"	3	10	1	136.4	98.6	.72	453	559	683	1.23	1.57
*[	9"×3½"×3½"×20.5#	3/8"	27"	3	9	2	127.0	88.8	.70	388	457	558	1.18	1.44
[	9"×3½"×21.8#	7/16"	27"	3	9	2	134.6	88.8	.65	375	457	651	1.22	1.74
*[	8"×3½"×3½"×18.7#	3/8"	24"	3	8	3	116.0	78.8	.68	319	396	485	1.24	1.52
[	8"×3½"×19.23#	13/32"	24"	3	8	3	120.0	78.8	.66	290	396	525	1.37	1.81
*[	7"×3½"×3½"×17.8#	3/8"	21"	3	7	4	106.0	69.0	.65	254	294	309	1.16	1.22
[	7"×3½"×18.25#	7/16"	21"	3	7	4	111.6	69.0	.62	244	294	360	1.21	1.48
Γ	7"×3½"×15#	7/16"	15"	2 1/7	5	5	90.8	49.3	.54	133	158	226	1.19	1.70
[	6"×3½"×3½"×15#	0.35	18"	3	6	6	93.3	59.1	.63	196	224	273	1.14	1.39
[	6"×3"×13.75#	3/8"	18"	3	5	7	83.9	49.3	.59	158	191	244	1.21	1.54
[	6"×3"×12.3#	5/16"	18"	3	5	7	76.8	49.3	.64	149	191	203	1.28	1.36
Γ	6"×3½"×13.5#	7/16"	15"	2 1/2	5	8	81.2	49.3	.61	101	158	226	1.56	2.24
*[	5"×3"×3"×12.6#	3/8"	16"	3 1/5	5	—	77.2	49.3	.64	126	168	208	1.33	1.65
Γ	5"×3"×9.8#	3/8"	14"	2 4/5	5	9	57.6	49.3	.85	60	144	177	2.40	2.95
Γ	4½"×3"×9.1#	3/8"	12"	2 2/3	4	10	53.3	39.7	.75	49	99	121	2.02	2.47
Γ	4"×3"×8.5#	3/8"	11"	2 3/4	4	11	49.1	39.7	.81	39	88	103	2.26	2.64
Γ	3½"×3"×6.6#	5/16"	10"	2 6/7	4	12	38.6	39.7	1.03	26	78	90	3.00	3.46

* PROPOSED NEW SHAPES



BEAM KNEES AND BRACKETS TAKEN FROM PRACTICE.

Columns 10, 11 and 13 of Table I show that, with the knees ordinarily used in the United States naval vessels, the resistance to shearing of the rivets in the majority of cases is from sixty to eighty per cent of the resistance to shearing of the beams. The resistance to shearing of the rivets would therefore limit the load that could be concentrated at the end of a beam under ordinary conditions. This load is, however, large in comparison with the load that can be concentrated at the middle of the beam even when considered with the weight of the beam itself. The deck beams of the Vermont are 10 in. x 3⅝ in. x 3⅝ in. x 21.8 lb., and are allowed to have a maximum span of 18 ft. between supports. Under this condition, the load which, when concentrated at the middle of the span, will rupture the beam by bending is 16.7 tons. This load added to the weight of the beam, 0.18 tons, gives a total load of 16.88 tons. From the table, column 11, we find that the rivets in one knee have a resistance to shearing of 98.6 tons, and will support a load six times as large as the total load given above.

The vertical stresses on the rivets due to loading the beams at the middle were found to be small when compared with the maximum horizontal stresses due to the bending moments. The resultants of the stresses due to the loads and bending moments were found to be but little larger than the stresses due to the bending moments alone. In the above case of the Vermont's deck beam, the following stresses were found:—

	Due to load. Tons per sq. in.	Due to bending moment. Tons per sq. in.	Resultant stresses. Tons per sq. in.
Shearing stress	1.91	18.09	18.13
Crushing stress in front of rivets	1.50	28.43	28.47

The differences between the resultant stresses in the table and the stresses due to the bending moment are less than one-half of one per cent of the resultant stresses. Since these differences are so small, the stresses due to the loads have been neglected. The resisting moments of the beams and the riveting in the knees only have been compared.

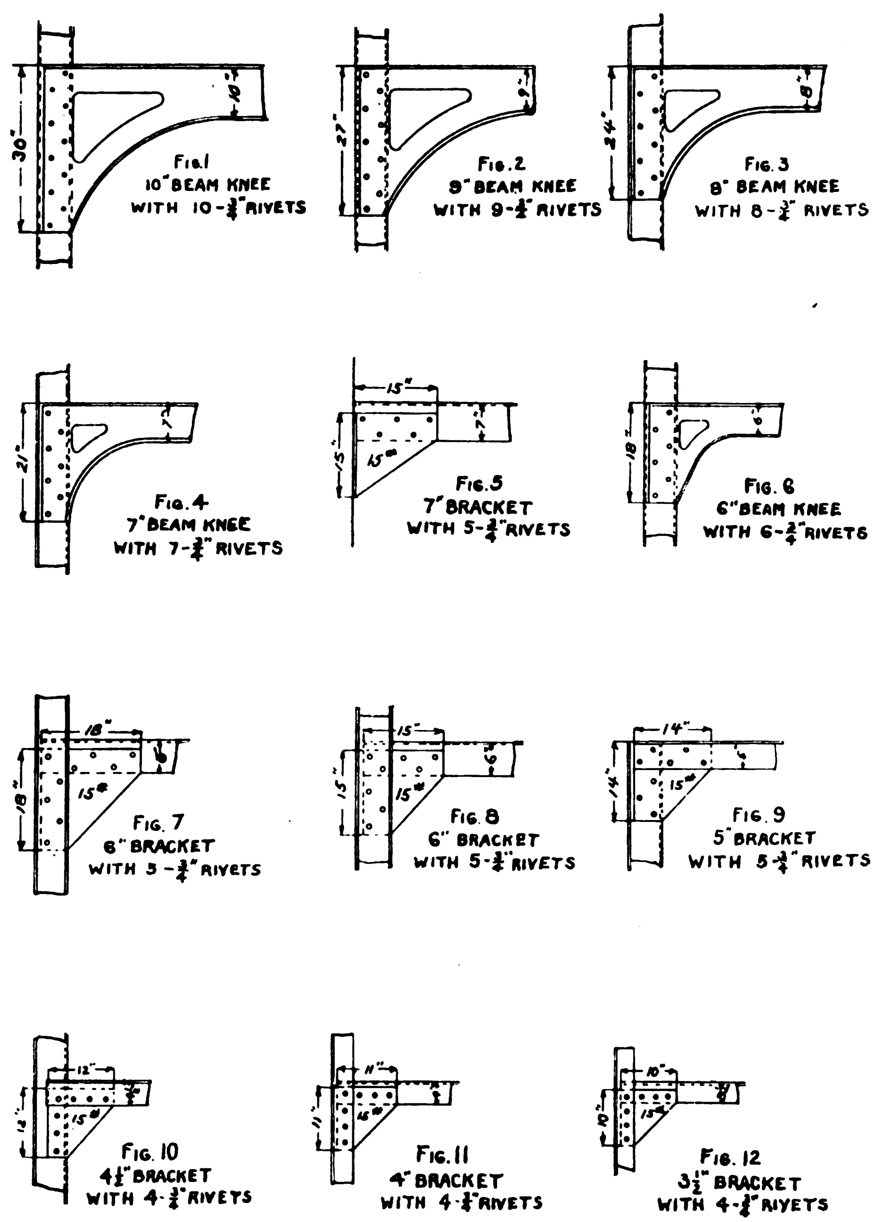
The resisting moments of the beams were calculated without taking into account the deck plating riveted to the beams, but considering one ¾-in. rivet hole in the shorter flanges at the sections of the beams. The deck plating was omitted because of the wide variation of thickness used on the same beam under different conditions.

Columns 15, 16 and 18 of Table I, Plate 1, give the moments required to rupture the beams and cause failure of the riveting by shearing or crushing of the metal. For comparison, the moments that will cause failure of the riveting required by Lloyds rules for the same knees are also given in columns 17 and 19 of the same table. These moments were calculated by the formula $f = \frac{My}{I}$, where f equals 63,000 lb. per sq. in. tensile stress, 50,000 lb. per sq. in. shearing stress, and 96,000 lb. per sq. in. crushing stress, and are expressed in foot-tons. The moment of inertia of the rivets in every knee has been taken about a pole through the center of gravity of the area of all the rivets in the knee.

Columns 16, 17, 18 and 19 show that the riveting of beam knees as required by Lloyds Rules gives approximately the same resistance as the riveting according to the ordinary practice in United States naval vessels. In general, however, the riveting for knees having a greater depth than 18 in., as required by Lloyds Rules, is slightly stronger than that used in United States naval vessels, and the riveting for knees having a depth of 18 in. and less, as required by Lloyds Rules, is somewhat weaker than that used in United States naval vessels. If we exclude the last four beams and the protective deck beam of the Olympia, the resisting moments of the riveting have a ratio to the resisting moments of the respective beams varying from 1.14 to 2.21 for United States naval vessels and 0.97 to 2.35 for Lloyds Rules in the case of shearing, and from 1.48 to 2.71 for United States naval vessels, and 1.18 to 2.46 for Lloyds Rules in the case of crushing the metal in front of the rivets. The largest ratios occurred in the 7-in. and 6-in. angle bars.

The variations in the above ratio appear too large. It seems more logical to design the riveting and depth of

BEAM KNEES AND BRACKETS RECOMMENDED



knee in such a way that the ratio of the resisting moments of the rivets to the resisting moment of the beam shall be kept between more narrow limits. It is recommended that these limits be made 1.20 and 1.60 for shearing, and 1.30 and 1.80 for crushing the metal in front of the rivets in the knees of all beams deeper than 5 in. For beams 5 in. in depth and less, it is recommended that sufficient rivets be used to close the joint efficiently without fixing the maximum value of the above ratios.

The Table II on Plate 3, and the sketches on Plate 4 have been prepared in accordance with the above recommendations. The desired ratios of resisting moments have been obtained by varying the depth of the knees or the number of rivets. In this table, ¾-in. rivets have been used for all beam knees, but, had any beam been of a thickness outside of the limits requiring ¾-in. rivets, it would have been necessary to use rivets of appropriate diameter for that thickness, and modify the number of rivets in order to keep the ratios of the resisting moments of the riveting to the resisting moment of the beam within the prescribed limits.

These results hold good for both knees and brackets used on either beams or stiffeners.

In the case of brackets the rivets should be so disposed that the brackets will be equally strong along both riveted sides.

The comparison between the resistances of a beam subjected to bending and the shearing of the rivets in its knees by twisting was originally done under the direction of Professor W. Hovgaard for use in the instruction of the assistant naval constructors at the Massachusetts Institute of Technology. The results of this comparison convinced the author that they would be of interest to this society. He therefore investigated the resistance of the metal to crushing in front of the rivets. The tables therefore show a comparison between the resistance of the beam and the resistance of the riveting in the beam knees to shearing and crushing of the metal in front of the rivets, when the whole beam is subject to bending.

Written Discussion by Robert Curr.

Robert Curr.—It will probably be of interest to add the methods practiced on the great lakes to Mr. Hunt's valuable and interesting paper.

Fig. 1 shows a beam connection. The frame and beam are 12 in. channel and the bracket is 15 lb. per sq. ft., flanged 3 in. deep on edge.

There are 12 rivets ¾ in. diameter, and are equal to the area of section of the beam or frame. The rivets

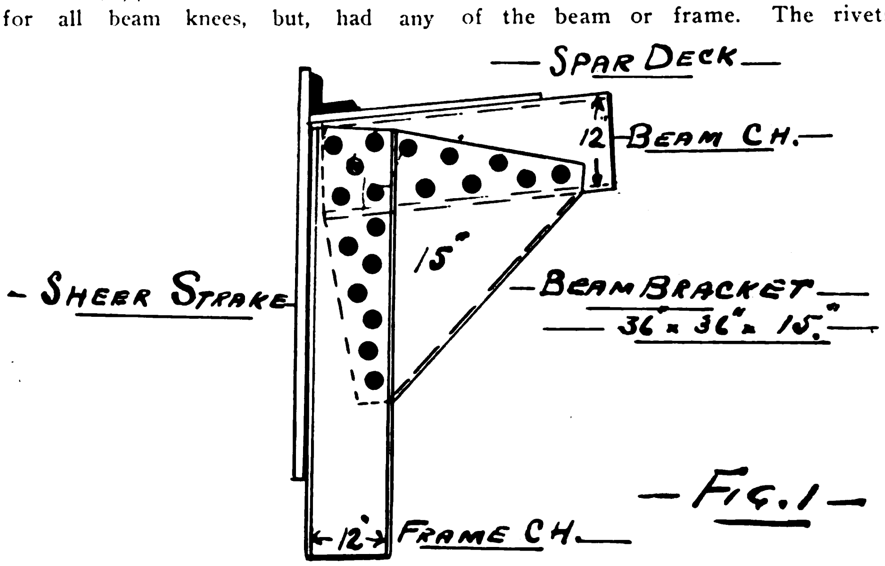
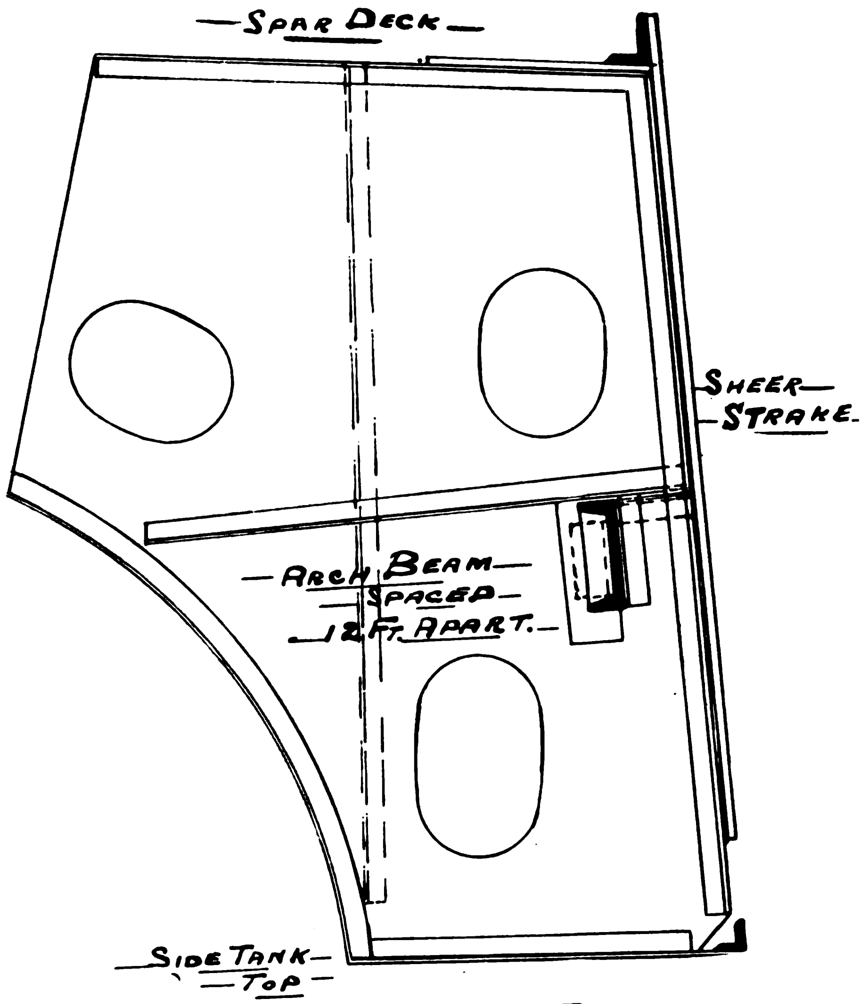


FIG. 1



—FIG. 2.—

and material are considered the same and have a value of 26 tons per sq. in.

The beam and frame are considered one piece from the center keelson to center keelson and where the frame is cut, a number of rivets are put in equal to the area of section of the material lapped or butted together.

This rule is considered throughout the ship and a table of rivets for standardized materials is supplied the men to assist in laying out the work.

The number of rivets, according to calculation, is one ¾-in. diameter rivet per in. for depth of web.

Example:—5-in. channel requires five rivets, 6-in. channel requires 6 rivets, 7-in. channel requires 7 rivets, 8-in. channel requires 8 rivets, 9-in. channel requires 9 rivets, 10-in. channel requires 10 rivets, 11-in. channel requires 11 rivets, 12-in. channel requires 12 rivets. Where the channels are increased in thickness over the standard sizes the diameter of rivets is increased.

Molds are made in the mold loft for all beam connections, which are carefully considered before passing on to the ironworkers.

Fig. 2 shows an arch beam connection to the ship side, which is built up with plate and angles, forming a deep web from side to side.

The bottom part of the beam is riveted to the side tank top and connected to same with a number of rivets equal to the area of section of the web frame.

When the web frame and arch beam are riveted up in the ship they form a belt in one piece equal to any section of the web frame through a line of rivet holes—its unavoidable weakest section.

Between the arch beams the channel beams are short, only running from the ship-side to the hatch opening, but the same number of rivets are put in these short beams.

In this case the number of rivets might be reduced, say, to 8 diameters of the rivet.

The side launching on the great lakes is a valuable test on beam connections.

Beam brackets have never shown any damage through this system of launching nor has there ever been any report of weaknesses of beam ends on the great lakes.

In Conclusion.

Stevenson Taylor, at the conclusion of the reading of the paper, said that his experiences in Detroit had been of the most delightful character, that he had renewed old acquaintanceships and made many valuable new ones and that he had learned something as well, having seen a back action engine in actual operation.

Upon motion of Mr. Babcock a resolution of thanks to everyone associated with the entertainment of the members was adopted.

In conclusion, President Bowles stated that it was his misfortune never to have been in Detroit before. He had seen many things to make him proud in his visit to the lakes and that the only thing comparable to it was the building of the American navy. He stated that the enthusiasm of those in attendance added to the regrets of those who were absent will arouse such a volume of interest as to result in further meetings of the society along the great lakes.

THE NEW CLERMONT.

Construction work on the replica of Robert Fulton's first steamboat, the Clermont, which will play an important part in the Hudson-Fulton celebration next fall, is progressing rapidly at the yards of the Staten Island Shipbuilding Co. at Mariners' Harbor, Staten Island, where it is being built. The boat will be ready for launching early next month and the interior work and the installation of the engine will be completed after it is afloat. The Clermont will be ready in ample time for participation in the celebration.

Sandwiched in between a modern commercial scow on one side and a palatial ocean going private yacht on the other, the Clermont certainly looks the part of the strangest craft seen around New York in a hundred years. At present her keel is laid, her planking is on, her bottom boards are placed and the construction of the interior has been begun. The bottom of the boat is absolutely flat for its entire length, the sides are almost perfectly perpendicular and the bows are sharply wedge-shaped. Most of the parts of the reproduction of the engine have been cast and are about ready for installation. The strange looking old fashioned boiler is just being finished and but for the installation of certain safety devices now required by law but unknown in Fulton's time the Clermont will be seen exactly as she was on Aug. 17, 1809, when she made her first trip.

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FIRST SUMMER MEETING OF THE NAVAL ARCHITECTS AND MARINE ENGINEERS.

The Society of Naval Architects and Marine Engineers is to be congratulated upon the success of their first summer meeting held at Detroit on June 24, 25 and 26, as to which all anticipations were fully realized. The quality of the papers presented for discussion was of a high order and it is to be regretted that a larger number were not present to take part in the discussion. The paper on "Some Model Experiments on Suction of Vessels" by Mr. D. W. Taylor, gives results of observations of towing models in various positions relative to each other and is noteworthy as the first serious attempt at research on what has always been a serious and perplexing problem. That Mr. Taylor's deductions are valuable goes without saying—anything bearing his name is always of value, but since the most serious cause of disturbance—the propeller—was absent, the premises are imperfect.

Mr. Taylor is inclined to think that propeller action is of small importance, whereas the everyday experience of those familiar with handling ships, is directly the opposite. So pronounced is it in fact, that a ship lying alongside a canal bank or another vessel is very often got clear with difficulty. The effects of suction caused by the propeller are to be observed even without any headway. Let two ships lie abreast, some little distance apart, and let the propeller of one be set in motion and the two vessels, if free to move, will inevitably be drawn together.

Propeller suction is part and parcel also of the increased resistance observed in shoal water, as may be shown by the fact that a hull of a given displacement may be towed at a given speed through a contracted channel without appreciable disturbance of water level, but a steamer of the same size can not be driven at a corresponding speed without disturbance more or less violent, depending upon speed, size and power of vessel. Mr. Taylor's deductions are applicable only to towed vessels and in deep water, conditions seldom or never existing where suction phenomena are most apparent, yet they are of value as a beginning and as furnishing data which is necessary in subsequent investigations.

The paper by Prof. C. H. Peabody on "A Method of Determining Pressures for Steam Turbines," goes into a subject which is of interest chiefly to turbine designers and classes in advanced engineering. Prof. Peabody is a prolific author and on questions involving discussion of the properties of steam, is a recognized authority.

Prof. Sadler's paper on "The Resistance of Some Full Types of Vessels," is another of those contributions growing out of the experiments at the experimental tank at the University of Michigan, for which the society has come to look with anticipation and is never disappointed.

The experiments bring out most clearly the effect of relatively small modifications of a type of ship which was not supposed to be susceptible of any radical improvement, thereby emphasizing the value of the tank to both builders and owners. In some instances the author stated that the reduction in power affected by the suggested modifications amounted to 25 per cent.

Incidentally, the curves illustrate forcibly the effect of shallow water on resistance and as was pointed out by a member, goes a long way in explanation of suction phenomena. We hope to have further communications from Prof. Sadler on his shoal water experiments as intimated in his paper.

The paper by Commander W. P. White, U. S. N., on "The U. S. S. Michigan, Renamed the Wolverine," is supplementary to the paper on the same subject by Mr. H. Penton, read at the November meeting. Commander White, who is in command of the old vessel, is as proud of her as though she were the new Michigan and has evidently taken a keen pleasure in collecting the information contained in his paper. He added that during his examinations he found evidence of pitting scarcely anywhere, a condition it is perfectly safe to say he would hardly have found had she been built of steel, even with the best of care. It is interesting to consider what would happen to this old ship if she ever came within the "sphere of influence" of a modern navy yard. There would certainly be little of her left, and the fact that no navy yard exists on the great lakes, is probably the chief reason why she is still spared to us.

Mr. Charles Ward's paper on "Shallow Draft River Steamers" was, as it deserved, well received. It contains a vast amount of information which has been hitherto inaccessible. The Western river steamer is almost *sui generis* and probably very little of the data concerning the type has ever been in recorded form, which makes Mr. Ward's paper all the more valuable and serves to call attention to the labor involved in its preparation.

The reasons for many apparent anomalies in their construction are made plain and the continued existence of others in the face of well

proved reasons for their abandonment, is pointed out. Mr. Ward is an untiring advocate of the screw in preference to the side or stern wheel paddles, and gives good reasons for the faith that is in him, but we fear much water will run out of the Kanawha and more than one generation pass away before the riverman's confidence in and love for the old, inefficient coal-swallowing type of river steamer is displaced. At all events, Mr. Ward has done a service in putting so much on record.

Mr. Alex. E. Brown's paper on "Material Handling Appliances on the Great Lakes" was canceled on account of the illness of the author. It is anticipated that the society will, however, have the pleasure of its presentation at the November meeting. Mr. Brown is probably, of all men, best equipped for the treatment of the subject, the modern methods of unloading tracing their inception to the first "Brown hoists" installed on the ore docks some twenty odd years ago.

The next paper, "The Strength of Knees and Brackets on Beams and Stiffeners," by Mr. Herman R. Hunt, is a comparison of the proportions used in the U. S. Navy with Lloyds Rules, and of the loads imposed on beam and rivet sections, with recommendations based thereon. It will be found of interest to ship builders and designers in their treatment of these members.

The paper on "Towing Problems" by Thos. S. Kemble, of the Chase Machine Co., Cleveland, was one of the most valuable of those presented, and involved an enormous amount of original research work. On both Atlantic and Pacific coasts and on the Great Lakes the towing of large consorts or fleets of barges on the towing machine has long been common and recently the Standard Oil Co. has adopted trans-Atlantic towing on a large scale. Accidents to hawsers and machines have occurred and controversies occasioned by reason of the excessive amount of dip allowed in hawsers, because masters insisted on using certain lengths of hawser without realizing either the actual necessity therefor or the amount of consequent dip or sag. No information or data has been available for their guidance and in any event it is impossible to estimate from the steamer or the barge the actual amount of dip. Mr. Kemble has put this in compact form so that, knowing the length of line out, which is of course simple, and the effective thrust of his ship, which is easily calculated for any speed and trim, and kept conveniently in a notebook for reference, a glance at the curve chart will give the sag for any of the sizes of line ordinarily used. Or, knowing the least depth of water (which is, of course, the maximum dip allowable) he can at a glance find the greatest length of line which can be used. There are other points treated, such as the stretch and strengths of wire and manila lines, the operation of the towing machine, etc., and a unique set of diagrams from a towing machine in heavy weather, illustrating the operation of the automatic device in paying out and recovery. As an example of the extent to which excessive lengths of line are sometimes carried, an instance is given of the hawser between the Iroquois and Navahoe fouling bottom in passing over the Grand Banks where the least depth is stated to be 70 fathoms. It is doubtful if the members of the Society realize as yet the enormous amount of patient labor required in the preparation of this paper and that very few would have undertaken it at all.

Altogether, to quote the words of Mr. Stevenson Taylor, "the next volume of the Transactions will be frequently referred to."

NAVAL COAL AND PACIFIC COAST SHIPPING.

The article elsewhere reprinted from *Railway & Marine News* is a sober and moderate statement of a disgraceful fact. It is an addition to the accumulating load of naval maladministration and reckless waste, even if no worse be said, which will inevitably end in disgrace and reorganization, if it does not in the meantime result in disaster. Disgust is too moderate a term to use; it does not fit the case nor will it help to rectify it. Stubborn wrongheadedness occurs to us as descriptive of navy methods. Surely we are an optimistic people to believe that the nation's defenses are best entrusted to those who care nothing for the nation's interests. Our enemies, if we have any, certainly could not wish our navy to be in better hands.

There is not only no reason why Pacific Coast coal should not be and is not perfectly suitable to our navy for peace purposes; but there is no justification for using any other. What under the sun would a fleet on the Pacific coast do in war time? Presumably haul coal across by rail. The worst that can be said of Pacific coast coal for naval work is that it is more smoky than that bought on the Atlantic coast. It is slightly inferior in heating value. But when freight is added, it will do double the work for a dollar that the eastern coal will do. The navy seems to think it exists for itself alone and is so bound up in its etiquette and ceremonials, that it has become entirely oblivious to every other interest.

Here is another swarm of foreign tramps turned loose on the Pacific coast without engagements, to further demoralize an already languishing shipping. If the navy cannot and will not move a finger in time of peace to help our shipping, God help it in time of war. Perhaps the lack of eastern coal furnished by favored contractors under a so-called "standard specification," will be a convenient excuse.

Over a year and a half ago, before the spectacular magazine attacks were made on the navy, there was submitted to THE MARINE REVIEW a series of articles bearing on the administration of the naval funds and the conduct of naval business by a gentleman well known in shipbuilding and engineering circles who wrote from actual contact and observation. At that time we hesitated to publish them and they have never been published, but beginning with the August number we shall begin their publication.

The navy has demonstrated over and over again its utter indifference to anything or anyone outside of itself and there is no reason why it should be

spared, when far bigger and more important interests are endeavoring to secure a fragment of the attention and assistance that the navy hogs for itself.

THE MARINE REVIEW is desirous of obtaining for a subscriber copies of THE MARINE REVIEW of Sept. 6, Sept. 20, and Oct. 4, 1906. The sum of $1 per copy will be paid for these issues.

NORTH GERMAN LLOYD STEAMER GEORGE WASHINGTON.

The steamship George Washington of the North German Lloyd line arrived in New York on June 20. She is the largest German trans-Atlantic liner afloat.

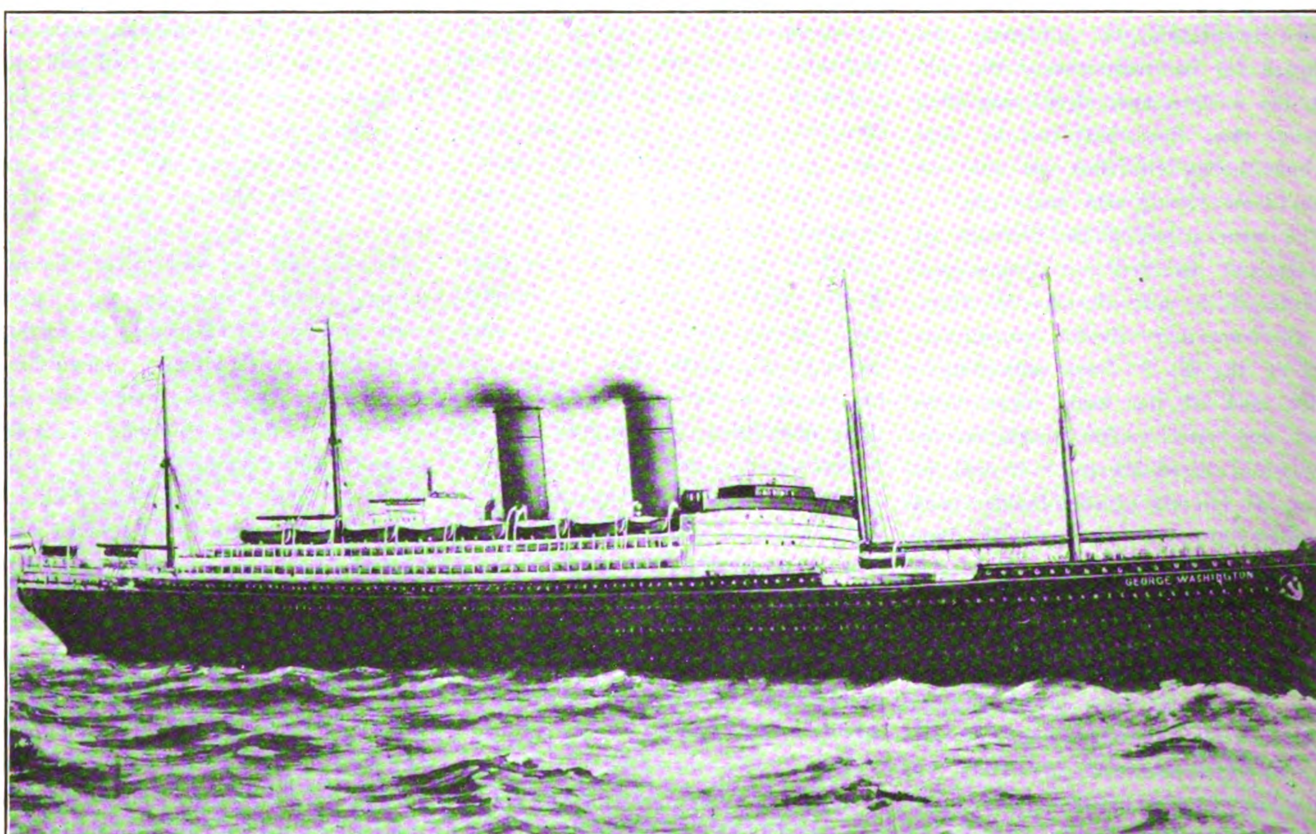
The George Washington is constructed as a first class twin-screw passenger and freight steamship with keelson and flat keel, vertical stem, elliptical stern and bilge keels. The vessel is equipped with a water tight double bottom, extending the entire length, divided into 26 compartments.

Twelve water tight transverse bulkheads, all reaching to the upper deck, and some even to the upper saloon deck, divide the ship into 13 water tight compartments, so arranged that even though two adjoining compartments should fill with water, the ship's stability would in no wise be affected. The bulkheads are constructed in accordance with the rules of the Germanic Lloyd and are so strong that one-sided water pressure can easily be withstood.

Two separate stairways are provided for all rooms below the saloon deck, between every two water tight bulkheads, making it possible, without disturbing communication, to keep all bulkhead doors below this deck closed during the night or in foggy weather, adding greatly to the safety of the ship and its passengers. Of the 36 water tight doors, 11 below the water level are equipped with the Lloyd-Stone closing device, first installed on the steamships of the North German Lloyd and now adopted by every great line. This device enables the doors to be closed by the simple turning of a wheel on the bridge deck. These doors may be closed and the ship practically hermetically sealed within 15 seconds. Hydraulic power closes the doors, but in order that the captain and the ship's officers may know whether or not a door is closed, there is a diagram in the chart house, and as each door closes a small incandescent light flashes up. Should, for any reason, a door not close by the hydraulic pressure, it may be shut by hand.

Other safeguards for the ship and passengers are a bell system for fire extinguishing purposes, with 14 alarm bells leading to the main quarters of the crew; a complete alarm bell system, with 30 bell stations for the ship and engine room system; a fire reporting system, with 18 fire alarm stations scattered over the vessel; and submarine bell signaling wireless apparatus. She also has Welin davits for launching life boats.

The George Washington was built in the yards of the Stettiner Vulcan at Bredow. Her dimensions are: Length, 722 ft. 5 in.; beam, 78 ft..; depth from upper saloon deck, 54 ft.; depth from awning deck, 80 ft.; speed, 18.5 knots; displacement at 33 ft. draught, 37,000 tons; gross registered tons, 27,000; H. P., 20,000; cargo capacity, 13,000 tons.



NORTH GERMAN LLOYD LINER GEORGE WASHINGTON.

THE YEAR'S SHIP BUILDING.

During the year ended June 30, 1909, 1,362 merchant vessels of 232,816 gross tons were built in the United States and officially numbered by the bureau of navigation compared with 1,506 of 538,627 gross tons during the fiscal year 1908, which was the record year of American ship building. This year's output was the smallest since 1898.

ALPENA'S TRIAL TRIP.

On May 25 a test was made on the new steamer Alpena, recently completed by the Detroit Ship Building Co. for the Michigan Alkali Co., of Wyandotte, Mich., to demonstrate her speed and coal consumption under loaded conditions. The steamer is 374 ft. long over all, 356 ft. between perpendiculars, 47 ft. beam and 26 ft. deep molded. She is designed for the special trade of carrying crushed limestone from Alpena to Wyandotte and is equipped with her own unloading machinery which is capable of delivering her cargo on the dock at the rate of 900 tons per hour. The propelling machinery consists of a quadruple, four-crank engine having cylinders 17½ in., 25½ in., 37 in., 54 in., with a piston stroke of 36 in. The engine is arranged with the low pressure cylinder forward, the second intermediate aft and the high pressure and first intermediate between. The low pressure and second intermediate cylinders have double ported slide valves driven direct by double bar link motion, the high pressure and first intermediate valves being placed on the front of the engine and actuated by "Joy" gear. The whole design is particularly compact, the working parts being all easily accessible and all wearing surfaces large and adjustable. The air bilge and cooler pumps are attached to the main engine.

Steam is supplied by two Scotch boilers 13 ft. 2 in. diameter by 11 ft. 6 in. long at a working pressure of 210 lbs. per sq. in. Each boiler has two 48-in. corrugated furnaces, the combustion chambers being separate. The Howden system of hot draft is fitted, the air being supplied by a "Sirocco" fan direct connected to an American Blower Co. engine. The propeller is four-bladed, 12 ft. 8 in. diameter and 13 ft. pitch. On the up trip the steamer in light trim made an average speed between Fort Gratiot and Thunder Bay of 13.55 miles per hour, the engines making 98 R. P. M. The contract conditions called for a speed of 11½ miles per hour when loaded to a mean draught of 18 ft., and a coal consumption not to exceed 1.3 lbs. per I. H. P. per hour, using coal of not more than 13,500 B. T. U. per lb. The rate of burning not to exceed 22.5 lbs. per sq. ft. of grate per hour, and the engines to develop the necessary power with a maximum revolution of 95 per minute.

The steamer was loaded at Alpena with as much stone as the comparatively shallow channel would allow, and then came to anchor in the bay where the water bottom was filled sufficiently to bring her down to a mean draught of 18 ft.

The speed test was made from Thunder Bay to Fort Gratiot and no attempt was made to force the machinery, the revolutions being set as near as possible to give the required 11½ miles per hour. The run as taken from the captain's log was 140½ miles in 12 hours and 6 minutes or an average speed of 11.54 miles per hour. The I. H. P. from cards taken every 30 minutes averaged 1,398 and the revolutions per minute 93.18. The machinery ran during the whole test without a suspicion of heating and there was a complete absence of vibration to the hull.

The coal was weighed for six hours during the test by a representative of the Michigan Alkali Co. and all the fires were cleaned once during that period. The coal was rather poor in quality, being about 70 per cent slack and showed on analysis a heat value of 12,855 B. T. U. per lb. with 13 per cent of ash.

The total coal consumed in six hours was 10,980 lbs. or at the rate of 1,830 lbs. per hour. This gives a consumption of exactly 1.3 lbs. per I. H. P. per hour, which, taking into account the quality of the coal and the fact that the test was made at night with the electric generator running during the whole six hours of coal weighing, shows the propelling outfit to be a remarkably economical one. The coal burned per sq. ft. of grate was at the rate of 21.78 lbs. per hour, and the I. H. P. per sq. ft. of grate was 16.64.

The Michigan Alkali Co. have expressed themselves as highly satisfied with the performance of the new steamer and are to be congratulated on such an efficient and economical addition to their fleet.

NEW STEAMERS FOR WILSON LINE.

The Harlan & Hollingsworth Corporation, Wilmington, Del., are building two steel single screw steamers for the Wilson line for express passenger and freight service between Philadelphia and Wilmington. The vessels are to be 205 ft. over all, about 190 ft. on water line, 40 ft. beam over guards, 32 ft. beam molded and 11 ft. 4 in. depth molded.

The forward part of main deck will be reserved for freight and will be covered with a steel house with three cargo ports each side. At after end of main deck will be the main entrance hall with purser's and captain's offices abaft, similar to the arrangement on the steamers Brandywine and City of Chester, the outstanding feature of the new ships being the amount of steel which has taken place of wood, making the new vessels more sanitary and less combustible. A stairway from main hall and from fore end of main deck leads to saloon deck. The saloon is a large space enclosed in a light steel house having large windows which afford a clear view to passengers sitting well inboard. The seats in this saloon are arranged athwartship, somewhat like a railroad car. This saloon deck is carried aft to stern and forward to stem, forming a large space for passengers outside of saloon itself. The after part of this open deck is shaded by the boat deck, while the fore part is exposed but protects the forward main deck space. Two stairways lead from saloon deck to boat deck where the pilot house and officers' quarters are located. The boats are also carried on this deck. A large space is left clear for sitting or promenading and the greater part of the deck is shaded by an awning. On the lower deck forward is crew space and abaft machinery on same deck space is provided for a cafe. The hulls of the vessels are larger than the older vessels and will be steered by steam steering gears. Machinery will consist of a triple-expansion engine, steam being supplied by two cylindrical boilers. The vessel will be lit by electricity and a large search light will be fitted. The vessels are designed to maintain the same speed as the older vessels, but being larger and heavier they have more power and should be able to keep up the schedule with train-like punctuality.

SUBMARINES LAUNCHED.

The submarine torpedo boats Bonito, Snapper and Grayling were launched from the yard of the Fore River Ship Building Co., Quincy, Mass., on Wednesday, June 16. The Grayling was christened by Miss Katherine Bowles, daughter of Rear Admiral Francis T. Bowles, president of the Fore River Ship Building Co. The Bonito was christened by Mrs. J. C. Townsend, wife of Lieut. Townsend, now stationed at the Fore River yard. The Bonito after going part way down the ways stopped and was not launched until the following day at 10 o'clock. The Snapper was christened by Miss Alice Nicoll, niece of L. Y. Spear, vice president and general manager of the Electric Boat Co. The Bonito and Snapper are duplicates of the Tarpon and Stingray which were launched some time ago, and the Grayling is a duplicate of the Narwhal.

THE HARBOR OF SEATTLE IN 1909. THIS VIEW SHOWS THAT PORTION OF THE HARBOR LYING NORTH OF MADISON STREET.

The Harbor of Seattle, Washington[1]

By H. Cole Estep

PUGET SOUND is the largest harbor on the north Pacific coast of the United States. The city of Seattle, situated on Elliot bay some 100 miles from the ocean, is the largest commercial port on Puget Sound. To a certain extent Puget Sound as a whole contributes to the harbor facilities of Seattle. The same is true of Tacoma and the other harbors which will be described subsequently in this series of articles. For this reason before taking up the study of Seattle harbor in particular we will discuss the harbor of Puget Sound as a whole.

The entrance to Puget Sound is through the Straits of Juan de Fuca. The general direction of the straits is north 84 deg. east, magnetic bearings. The variation of the compass is 24 deg. 30 min. east, therefore the true direction of the straits is east 18 deg. 30 min. south. The straits are 15 miles wide at the entrance, 20 miles wide at Victoria harbor, 10½ miles wide at the narrowest point opposite Beechey Head, and 90 miles in length. The length is measured from the intersection of the international boundary line with the meridian through the Tatoosh island light, thence east on the international boundary line to a point due south of Bentinck island, B. C., thence due east to the intersection with the meridian through Smith island light. The minimum depth of water on this line is 30 fathoms, near Partridge banks, the maximum depth is 146 fathoms, north of Tatoosh island, while the average depth of the straits in the center is 80 fathoms. The water is deep enough to float large vessels practically from shore to shore; the 10-fathom contour is generally not more than one mile from shore, at many places it approaches as close as 1,000 feet, while at no point is it more than two miles from the line of mean low tide. No harbor in the world has a more spacious gateway; the straits are wide, deep and free from obstructions, shoals or bars.

The prevailing winds in the straits are northerly in summer and southerly in winter. The tidal currents are not generally troublesome. The storms in winter are often very severe. As a result there have been a number of disastrous wrecks in the vicinity of Cape Flattery and on the southern shore of Vancouver island. These wrecks, however, were nearly all caused by the usual dangers incident to navigating the northern seas in winter and cannot be ascribed to any peculiar dangers at the harbor entrance. It is generally agreed that the entrance to Puget Sound is inherently less dangerous than the bars, shoals, etc., guarding the other harbors of the Pacific coast and many of those of the Atlantic coast as well.

While the conditions are such that ships and large lumber schooners are usually able to sail as far in as Point Wilson, and while they do occasionally sail even as far as Seattle or Tacoma, the great majority of the sail tonnage entering Puget Sound is towed into port. The towing charges vary from $95 for a 250-ton vessel to $300 for a 1,500-ton vessel towed between Cape Flattery and Seattle. Table I, presented herewith, gives some of the towing charges in detail. These charges place Puget Sound, as far as towing is concerned, practically on a par with the Columbia river and at a disadvantage as regards San Francisco.

Between Point Wilson at the inner end of the straits and Seattle is a body of water strictly known as Admiralty Inlet, although the general name Puget Sound also applies. This inlet, from Point Wilson to Seattle, is about 45 miles in length. Its general bearing is east 35 deg. south magnetic and east 56 deg. south by the true meridian. The minimum depth at the center of the channel is 23 fathoms; the maximum depth is 148 fathoms, and the average depth is 68 fathoms. The channel is deep from shore to shore, the 10-fathom contour being on an average not more than half a mile from the high tide line. In the main channel the tidal currents do not run more than two knots an hour on extreme tides while at most stages of the ordinary tides the currents are quite negligible. The range of tides in Elliott Bay between mean low-water and mean high-water is 11.5 ft.; the distance between the mean of all high-waters and the mean of all low-waters is 7.6 ft. The entire channel, from Cape Flattery to Tacoma, is well lighted and buoyed. At Neah Bay, near Cape Flattery, is stationed the U. S. life-saving tug

[1]Second of a series of articles describing the principal harbors of the North Pacific coast.

TABLE I.

DETAILS OF TOWING CHARGES ON PUGET SOUND, SINGLE AND DOUBLE DECK VESSELS.

(From the Biennial Report of The Port of Portland Commission, 1907-8.)

PUGET SOUND—SINGLE DECK VESSELS.

Between Cape Flattery and

Tons.	Port Angeles.	Port Townsend.	Hadlock.	Port Gamble, Port Ludlow, Roche Harbor.	Bellingham, Everett, Port Madison, Seattle, Port Blakely, Ballard.	Tacoma, Cowichan, Chemainus, Ladysmith.	Olympia, Moodyville, Vancouver, Nanaimo, Steveston.
150 to 250	$ 40	$ 65	$ 75	$ 85	$ 95	$105	$135
251 to 350	45	75	90	105	115	125	155
351 to 450	50	85	102	120	135	145	175
451 to 500	53	90	109	128	145	155	185
501 to 550	55	95	115	135	155	165	195
551 to 600	58	100	122	143	165	175	205
601 to 650	60	105	128	150	175	185	215
651 to 700	63	110	134	158	185	195	225
701 to 750	65	115	140	165	195	205	235
751 to 850	100	160	188	215	230	245	260
851 to 1,000	125	175	200	225	250	275	300
1,001 to 1,200	150	200	225	250	275	300	325
1,201 to 1,500	175	225	250	275	300	325	350

PUGET SOUND—DOUBLE DECK VESSELS.

To or From Cape Flattery and the Following Places:

Tonnage Vessels From.	Royal Roads, Port Angeles.	Discovery, Townsend, Diamond Point.	Hadlock.	Gamble, Ludlow.	Everett, Madison, Ladysmith, Chemainus, Seattle, Cowichan, Blakely, Bellingham.	Tacoma, Utsalady, Nanaimo, Vancouver, Moodyville, Steveston.	Comox, B. C.
851 to 1,000 tons	$125	$175	$200	$225	$250	$275	$300
1,001 to 1,200 tons	150	200	225	250	275	300	325
1,201 to 1,500 tons	175	225	250	275	300	325	350
1,501 to 1,800 tons	200	250	275	300	325	350	375
1,801 to 2,000 tons	225	275	300	325	350	375	400
2,001 to 2,500 tons	250	300	325	350	375	400	425
2,501 to 2,750 tons	275	325	350	375	400	425	450
2,751 to 3,000 tons	300	350	375	400	425	450	475
3,001 to 3,500 tons	325	375	400	425	450	475	500

Towage to or from Fraser river points above Stevenson subject to special rates.

Hawser Charge.—Vessels 500 tons and under, $5 each way; vessels over 500 tons, $10 each way.

Rate from Vancouver to Sound ports above Port Townsend on vessels of 1,000 tons and over, same as sea rate to Sound ports. Vessels towing from sea to Tacoma or Seattle and calling at Port Townsend or Port Angeles for orders, will be given a direct rate. Captains to wire agent of tugs 48 hours' notice of when tug is required.

Snohomish, which is the most completely equipped vessel of its kind in the world.

Puget Sound is indented with numerous bays and inlets which offer excellent shelter and anchorage. The entire sound, from Point Wilson to Olympia, a distance of 105 miles, is one grand harbor, large enough, deep enough and roomy enough to shelter the navies of the world. Add to these very favorable conditions absolute freedom from ice and a climate that seldom registers a temperature below 25 deg. Fahr., and it is easily seen that the natural harbor facilities of Puget Sound are very unusual.

The six requisites for a good harbor may be summed up in (1) protection from storms, (2) ample depth and good anchorage, (3) size, (4) accessibility, (5) sufficient shore line for the construction of the necessary docks and wharves, and (6) facilities for handling freight and for the repair of vessels.

Elliot Bay, which is, properly speaking, the harbor of Seattle, is 135 miles from the open sea, it is protected on the west by the Olympic mountains and on the east by the Cascades; immediately surrounding the bay are high hills. The bay opens to the northwest but at no point is there an open sweep of more than eight miles. The protection from the prevailing winds of winter is complete. In general the harbor is so protected that except at very rare intervals it is perfectly safe for row boats.

The depth of water in Elliot Bay varies from 9 to 65 fathoms; there are nearly 2 sq. miles of anchorage in water between 20 and 35 fathoms deep. The harbor is accessible for all vessels at all times of the year and under any weather conditions. The area of Elliot Bay is 6 sq. miles. The shore line of Seattle harbor, including the dredged waterways, is about 20 miles.

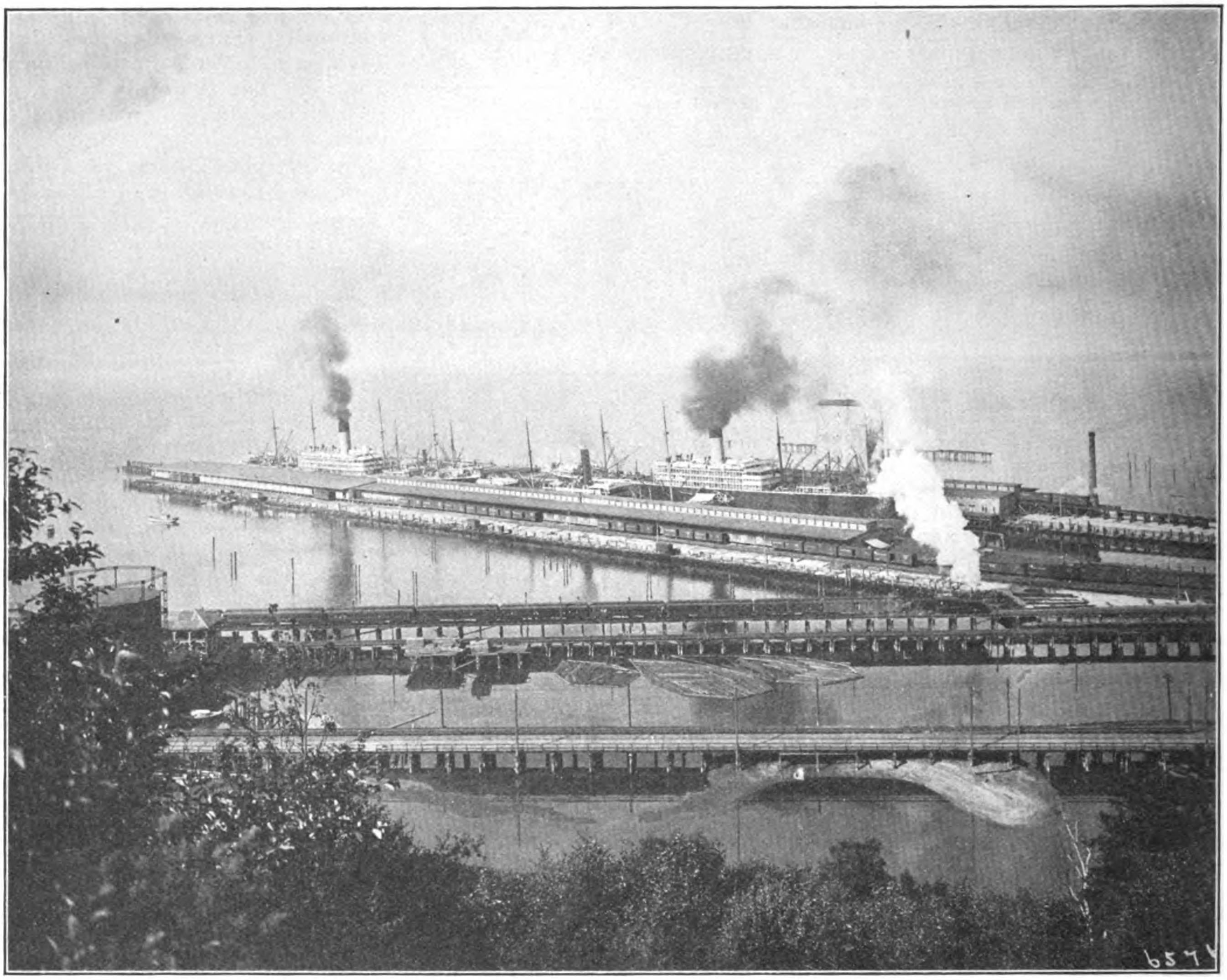
The foregoing gives in some detail the natural facilities and advantages of Seattle harbor. Two features remain to be considered: (1) the amount of shippng centering in Elliot Bay and its probable future increase; (2) the facilities for taking care of the traffic and the plans for future improvements.

The water-borne traffic centering in Seattle is of three kinds: local, coastwise and foreign. In studying this commerce one is at once impressed by the marvelous growth of the business of this enterprising western sea port. The following quotation from a recent issue of the *Seattle Post-Intelligencer* gives a number of interesting figures bearing on this point:

"When the fire of June 6, 1889, swept away the business portion of Seattle, the city's area was about 20 sq. miles. It is now 55 sq. miles. In 1888 Seattle's population was 28,000; it was 47,000 in 1890, and in 1909 it has jumped up to nearly 310,000, with a floating population second to no other city of its size. Moreover, the assessed value of property has increased from about $16,000,000 in 1889 to $178,136,718 in 1909. While Seattle had 12 banks, with resources worth, approximately, $10,000,000 in 1889, the city now has 26 banks, with resources worth probably more than $75,000,000. Bank clearings for the first week after the fire 20 years ago amounted to only $610,031; the weekly average now is about $11,000,000, and it is not uncommon for the daily clearings to range anywhere from $2,000,000 to above $3,000,000.

Seattle had practically no foreign trade in 1889. Customs receipts in 1908 reached a total of $1,252,295. The total annual outgoing tonnage is close to 2,000,000, and the incoming tonnage is slightly under the total of the outgoing tonnage. Exports in 1908 were valued at $47,129,169, and the value of imports reached a total of $57,655,070 for the same year. Alaska's business alone is worth $30,000,000 a year, and Seattle's trade with Japan, China, Australia, Hawaii and the Philippine Islands is steadily expanding."

The local shipping of Seattle is carried on by a large number of small steamers locally termed the mosquito fleet. There are about 70 of these steamers plying between

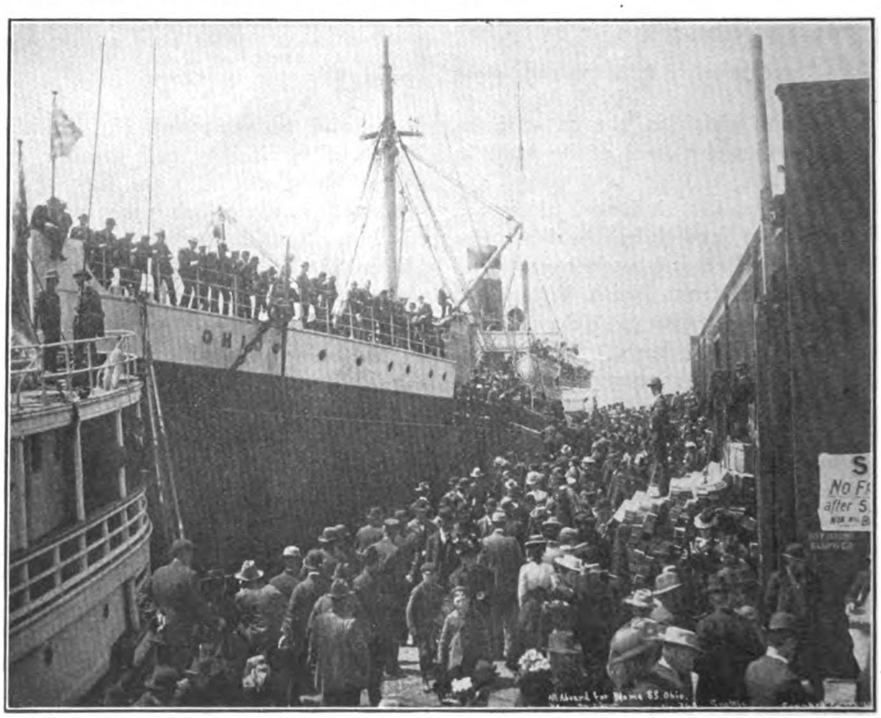


Docks of the Great Northern Railway at Seattle. This Photograph Was Taken Before the Wreck of the Dakota. Both the Dakota and Minnesota Are Seen at the Dock, Also Two Ocean-Going Steamers, Giving Some Idea of the Immense Size of the Piers.

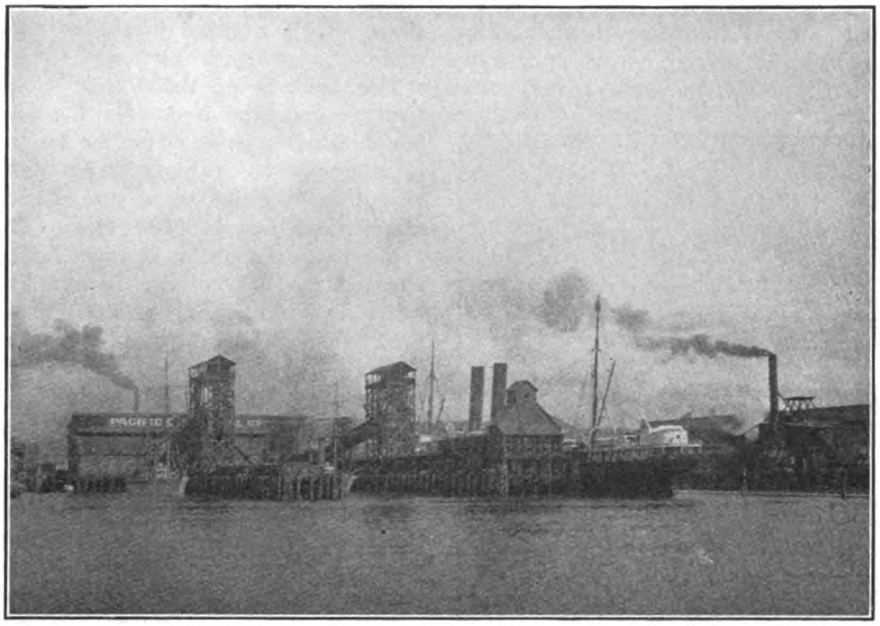
Seattle and all points on Puget Sound. The service afforded by these vessels is rapid, economical and convenient. The annual value of this local trade is $25,000,000.

It was not until 1896 that the coastwise and foreign trade of Seattle began to assume important proportions. Previous to that time the only regular service had been to San Francisco. Today Seattle controls the Alaska business, offers the shortest route from the Pacific coast to the orient and has regular steamship connections with Mexico, Panama, South America, Hawaii, Australasia, the west coast of Africa, Europe and the Atlantic coast of the United States.

Prior to 1890 there was no foreign trade route direct to Seattle and no custom house at Seattle; all foreign shipments had to pass through the Port Townsend custom house. Most of the oriental and European freight of those days came via Vancouver, B. C., where it was discharged and reloaded on the old steamers Olympic,



S. S. Ohio Leaving Seattle for Nome. In the Early Season Vessels to the North Are Always Crowded with Passengers and Freight.



Bunkers of Pacific Coast Coal Co., Seattle.

Premier, North Pacific and Eliza Anderson for shipment to Seattle via Port Townsend. The only sailing ships coming to Puget Sound in those days were a few tea ships and barks seeking lumber charters.

At the conclusion of the fiscal year 1907-08, the total customs house collections of Seattle were $1,252,295.36, and for the ten months between June, 1908, and May, 1909, the collections were $818,218, the falling off being due to the general trade depression. The Seattle customs house at present employs 45 men.

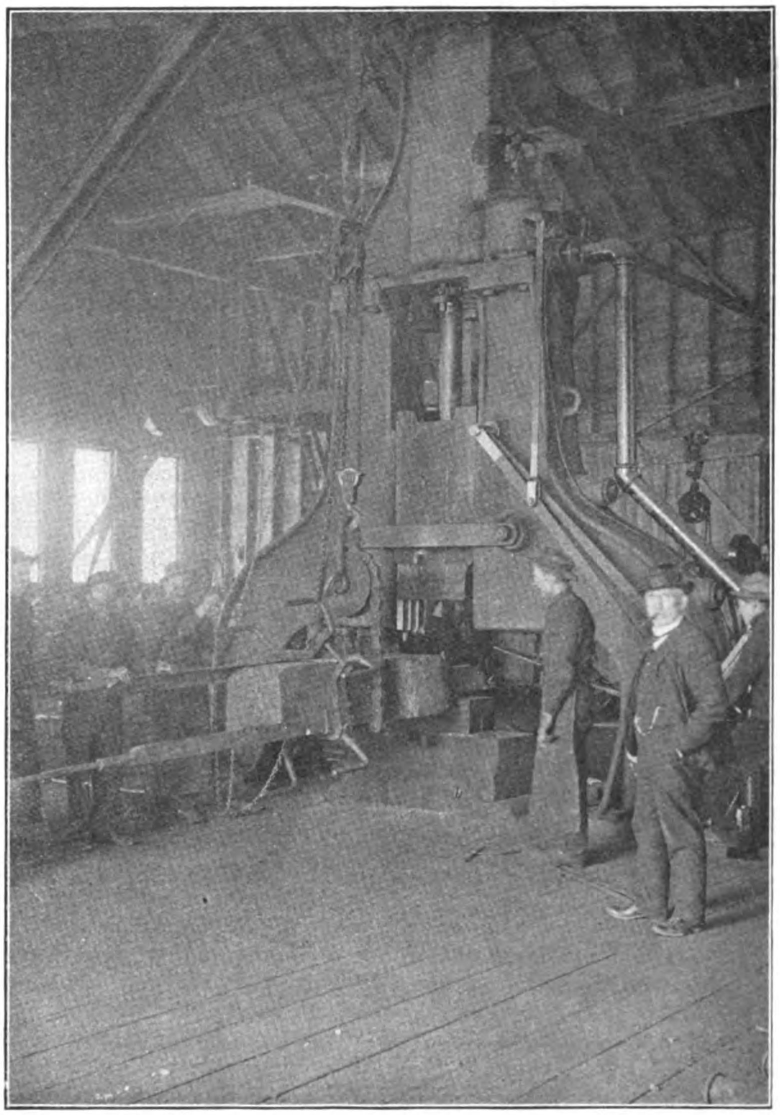
The harbormaster's statistics of the port of Seattle for the year ending Dec. 31, 1908, are as follows: Deep sea vessels inbound, 957, of which 76 were sailing vessels. Net tonnage inbound, 1,720,406. Deep sea vessels outbound, 781, of which 57 were sailing vessels. Net tonnage outbound, 1,658,222. Passengers inbound, 1,421,635, including Alaska and all foreign travel; passengers outbound, including Alaska and foreign ports, 1,409,020. Imports by water from coastwise and Alaska ports for the year were valued at $33,849,343. Foreign imports were as follows: From the Orient, $20,600,120; from Germany, $624,400; from British Columbia, $2,336,907, from the United Kingdom, $243,300. Total foreign imports, $23,804,727.

Exports to Bering Sea (Alaska) were $4,534,520; to coastwise ports, $17,718,545; to southern Alaska ports, $7,437,962; to New York, $125,520; to Hawaii, $1,412,591; to local ports, $15,900,031. Total domestic exports, $47,129,169.

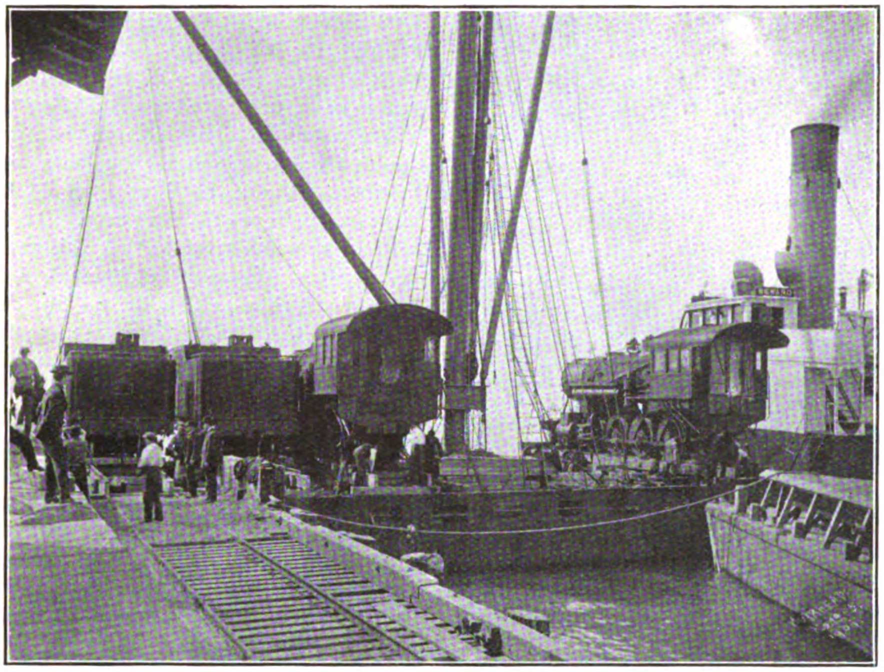
Exports to the Orient were $10,466,654; to the Philippines, $1,316,137; to Siberia, $819,317; to British Columbia, $2,010,127; to Germany, $1,979; to South America $596,548; to England, $3,102,206; to Australia, $48,076; to South Africa, $9,691. Total foreign exports, $18,370,735.

The total water-borne imports in 1908 amounted to $57,655,070, and the exports to $65,129,169. The imports of gold from Alaska in the past ten years have amounted to $175,000,000. The year under consideration was undoubtedly a bad one for business and in normal times the figures would be increased about 15 per cent. It is well to remember, also, that this traffic, foreign, domestic and local, has been practically all built up in the past 20 years. If the increase in the next two decades is only half as fast as it has been in the last two, Seattle's imports in 1929 will be nearly $90,000,000 and her exports nearly one billion.

What facilities does the harbor provide for this traffic and what provisions are being made for future growth? As was stated above, the shore line at present is about 20 miles



Steam Hammer in the Plant of Westerman Iron Works, Seattle.



S. S. SEWARD LEAVING SEATTLE FOR ALASKA, LOADED WITH RAILWAY SUPPLIES, INCLUDING TWO LOCOMOTIVES.

in length. The total dock frontage is now 37,023 ft. The minimum depth of water at the docks is 18 ft., while the average depth is 40 ft. Below is a list of the principal docks, giving their dimensions and warehouse area:

Ocean Docks.	Dimensions in ft. The distance the pier extends into the water is given first.	Area of warehouse, Sq. ft.	Dimensions of slip, in ft.
[1]C. M. & Puget S. Ry.	501x115	58,600	
Pacific Coast Co., Bunkers	450x100		
Pacific Coast Co., Bunkers	350x 40		370x80
Pier D	450x180	46,800	130′ wide
Pier C	370x120	33,600	90′ wide
Pier B	380x120	31,400	110′ wide
Pier No. 1	480x140	45,000	100′ wide
Pier No. 2	750x140[2]	60,000	90′ wide
Pier No. 4	320x110	19,500	
Pier No. 5	350x130	29,100	
Pier No. 6	320x130	27,000	
Pier No. 7	400x110	29,600	
Pike St. Wharf	450x100	23,400	
Pier No. 10	380x200	44,100	
Pier No. 11	130x400	39,000	
Wall St. Dock	450x120	34,400	
Roslyn Coal & Coke Co., Bunker	250x 70		
Pier No. 14	400x170	30,000	
Great Northern R.			
Smith Cove (1)	1800x200	10[illegible],5[illegible]0	
Smith Cove (2)	1800x200	50,000[3]	1750x80
Local Piers:			
Colman Dock	705x110	54,000	90′ wide
Flyer Dock	170x 70		
Galbraith Dock	290x150	20,800	

[1]On East Waterway near Lander Street.
[2]Pier being rebuilt, dimensions approximate.
[3]Elevator.

The freight docks are all provided with spur tracks and ample railroad connections. The spurs are arranged so that freight may be directly transferred from the cars to vessels or vice versa. Several of the docks have cranes for handling heavy freight. The piers of the Great Northern railway are equipped with an elevator and special facilities for handling grain. The several export flour mills located at Seattle each have special facilities for shipping grain and flour.

The bulk of the passenger traffic centers in three piers, the Colman dock, Flyer dock and Galbraith dock.

The Galbraith dock has an overhead walk and other special facilities for handling passenger and light freight traffic. The Flyer dock is used exclusively by the steamer Flyer operating between Seattle and Tacoma. The Colman dock is one of the finest passenger piers on the Pacific coast. This dock was completely described in the Dec. 3, 1908, issue of THE MARINE REVIEW. The pier is 705 ft. in length and 110 ft. in width. There is a completely appointed waiting room on the second floor. The pier has adjustable slips to compensate for the rise and fall of the tide. The dock has its own heating plant, lunch room, toilet accommodations and other facilities appreciated by travelers.

Seattle harbor is more favored from a fuel standpoint than any other Pacific coast port. The mines are close, the fuel is cheap and the bunkers are unusually large, well equipped and modern. There are three coal bunkers in the harbor for vessels: the Northern Pacific railway bunkers at West Seattle, the Rosyln Fuel Co., at the foot of Clay street, and the Pacific coast Coal Co., at Dearborn street. The bunkers of the Northern Pacific and the Roslyn Fuel Co. are ample for Sound steamers and medium sized vessels engaged in the coasting trade.

The bunkers of the Pacific Coast Coal Co. are the largest in the harbor and can accommodate the largest ocean-going steamships. The daily output of the mines of the Pacific Coast Coal Co. is 4,000 tons. The bunkers consist of a storage house, situated parallel to the harbor line which has a capacity of 5,000 gross tons. This storage house is reached by an inclined trestle which has a capacity of 20 standard coal cars. Built at right angles to the storage house and extending into the bay for a distance of 450 ft. are two piers, each carrying a conveyor and a loading tower. There are two loading chutes on each tower, so that four ocean steamers may coal at once. Each chute has a loading capacity of 400 tons per hour. The outer end of the conveyor, the tower pockets and chutes are capable of vertical adjustment to correspond with the tide. This is done by carrying the pockets on a hinged trestle and counter weighting. There are three chutes for coaling tugs and also 14 individual pockets for tugs, each pocket holding two carloads of coal.

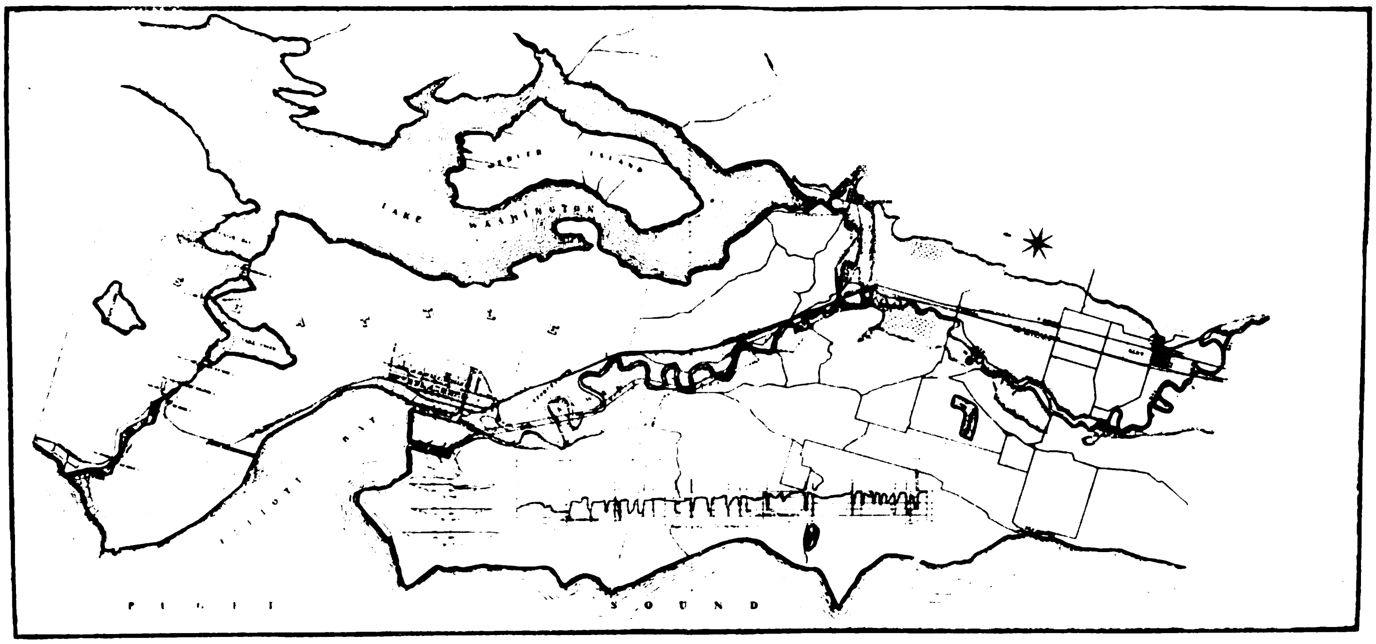
Most of the steamships burn Black Diamond mine run coal. This fuel is delivered f. o. b. bunker tips for $3.75 per gross ton (2,240 lb.). The steamers either trim their own bunkers or have the trimming done by the coal company. The cost of trimming bunkers varies from 15 to 25 cents a ton.

Below are analyses of Black Diamond and Roslyn coal taken from the Twenty-second Annual Report of the United States Geological Survey:

	Black Diamond, Per cent.	Roslyn, Per cent.
Moisture at 110° Cent.	3.040	2.05
Volatile matter other than water	36.566	33.55
Fixed carbon	56 084	54.55
Ash	4.166	6.85
Sulphur	0.144	0.106
Phosphorus	0.023	not det.
Increase in weight at 250° Fahr.		0.402

The small amount of sulphur is worthy of note. The increase in weight shown in the last line is a measure of the tendency of the coal toward spontaneous combustion.

While Seattle has no public dry dock, such as is possessed by Portland, the harbor is abundantly supplied with repair facilities. Four dry docks for large vessels and a number of marine ways for smaller craft are available. The dry docks are owned by the United States government, The Moran Co., the Heffernan Dry Dock Co., and Hall Bros. Marine Railway



MAP OF PROPOSED IMPROVEMENT TO DUWAMISH RIVER, SEATTLE.

& Shipbuilding Co. The government dock is at the navy yard, Puget Sound, Bremerton, Wash., 16 miles from Seattle. This dock is available for merchant vessels when not in use by ships of the navy. It is the largest dry dock on the Pacific coast. It is over 600 ft. long and has a capacity for ships up to 25,000 gross tons.

The Moran company's dock is at Seattle. It is a floating dock, 200 ft. long, 54 ft. 3 in. wide in the clear, with a lifting capacity of 2,600 tons.

The marine railway operated by Hall Bros. Marine Railway & Ship Buildng Co., is at Eagle Harbor (Winslow post office) 9 miles from Seattle. It is one of the largest marine railways in the country. The length of the cradle is 325 ft., the draught is 23 ft. aft and 20 ft. forward. The beam is 79 ft. and the capacity 4,000 tons dead weight.

The dock of the Heffernan Dry Dock Co is of the floating type. It is 385 ft. in length, 100 ft. beam and 8,000 tons capacity. It is situated at Quartermaster Harbor, near Seattle, and is operated in connection with the Heffernan Machine Works, Seattle.

In connection with each of these docks there is operated a completely equipped plant for the repairing of ships and machinery. The Moran Co. and Hall Bros. Marine Railway & Ship Building Co. also operate extensive plants for the construction of new vessels.

The foregoing outlines the splendid natural advantages of Seattle harbor, the growth and extent of the city's marine commerce and the facilities now available for handling the traffic. There remains yet to be considered the needs of the future and the steps that are being taken to meet these needs. The commerce of the city is growing at a surprising rate; if the shipping continues to increase at even half the present rate, it will not be many years before the 20 miles of shore line now available for docks and warehouses will be inadequate. The water front of Greater New York amounts to 445 miles; the dock frontage is at present 62 miles in length. It may be a good many years before Seattle is as large as New York, but at the present rate of growth it will not be many years until it is half as large. In spite of these facts the city, as a public body, is doing very little toward the improvement of its harbor. Several large improvement projects have been proposed and are at present being agitated. One is the construction of a sea wall between King street and Smith cove, filling in the property between the wall and high tide; another is the building of a 25-ft. ship canal from Salmon bay through to Lake Union and Lake Washington, making these two bodies of water practically part of the harbor; a third project involves deepening the east and west waterways and the straightening and deepening of the Duwamish river to its source, providing a 16-ft. channel 150 ft. wide to the source of the river. It is not within the purpose of this article to go into the merits of these various plans concerning which there has been a great deal of local discussion and recrimination. The solution of the problem is a purely engineering matter. The fact remains, however, that at present the weakest point in Seattle's splendid harbor system is the lack of intelligent, systematized and unified effort toward providing larger and better facilities for the future. Provision for future growth must be made somehow; it would be best to have the execution of the necessary work in the hands of a centralized, expert body, endowed with sufficient skill and wisdom to act for the best interests of the community and with authority to work out a unified scheme. Already steps have been taken toward this end. It is safe to assume that the city will not suffer its hard-earned precedence to wane because of insufficient or thoughtless provision for the future needs of its marine commerce.

QUICK TIME FROM HONG KONG.

The first cargo from the far east via the new Tehuantepec-Orient route arrived in New York on June 1 by the steamer Lewis Luckenbach. The steamer Erroll, of the Mexican-Oriental Steamship Line, Ltd., which inaugurated the new service, left Hong Kong April 8, and after calling at ports in Japan made a good passage to Salina Cruz, Mexico. Her cargo was promptly trans-shipped across the isthmus to Puerto Mexico and brought here by the connecting steamer of the American-Hawaiian Steamship Co. The time in transit through to New York was: From Hong Kong, 53 days; from Kobe, 45 days; from Yokohama, 43 days. The cargo arrived in first-class condition.

THE NAVY DEPARTMENT VS. OUR PACIFIC COAST OWNED VESSELS.

While Mr. Taft's administration in those respects that effect large combination of capital in the eastern states has apparently abandoned the Roosevelt policy, it continues to maintain the policy employed by every, president occupying the executive mansion since Harrison, to use its influence to discriminate against American shipping. *Railway & Marine News* can scarcely find words to express its disgust because of the navy department's most recent outrage perpetrated against Pacific coast American shipping and regularly established lines.

Recent advices announce the charter by the navy department of 12 British colliers to transport about 75,000 tons of Pocahontas coal from the Atlantic to the Pacific. The names of these vessels and their probable capacities are S. S. Strathfillan, 6,100 tons; Strathgoe, 6,100 ton; Strathgyle, 6,100 tons; Headley, 6,000; Belle of Scotland, 7,000; Guernsey, 6,100; Cape Finisterre, 6,100; Hutton Wood, 5,600; Hynford, 6,000; Riverdale, 6,000; Baron, 6,000 and Forsdale, 6,000, making a total of 73,100 tons.

It was fair for the shipping people here to expect, that because of the many protests and appeals against the policy employed by the administration prior to January, 1909, that the government would reduce its coal tonnage to this coast and would purchase instead at least a portion of its fuel requirements either on Puget sound or in British Columbia.

The policy of the administration in bringing coal here had more to do with our shipping demoralization in 1908 than did the panic of 1907 and the depression that followed, and the chartering of the above vessels will cinch the demoralization that did and does at present exist.

These charters have been made in the face of the numerous protests to the head of the naval board, the head of the bureau of equipment and the secretary of the navy.

Last year the naval board summoned Admiral Cowles before it to explain the government's policy in thus transporting coal, and in due time the head of the naval board announced that an inquiry had been held and that while the board was sorry it could not do anything for the complaining shipping companies on the Pacific coast. The administration did not want to do anything, their inquiry was not made in good faith, if so why did it confine itself to the statement of Admiral Cowles; why did not that board extend its enquiry to the coast, to there ascertain for themselves if suitable coal in sufficient quantities could not be supplied? They did not extend their inquiry beyond the confines of the room where Admiral Cowles' statement was heard; had they desired to give our ships the remotest assistance they could have ascertained at the treasury department that Puget Sound stands third in the nation supplying fuel coal; it could have learned that one firm alone in British Columbia, a few miles from Bremerton, 800 miles from San Francisco, and without 2,000 miles of Magdelena Bay, produces three-quarters of a million tons of fuel coal annually; by examination of the navy department's records it could have found that about three years ago the Bremerton yard made a test of Comox, B. C., coal, and that test placed that coal only about 6 per cent less in efficiency than Pocahontas, still they ship eastern coal, in vast fleets of foreign bottoms, and say to us they are sorry, but cannot help complaining Pacific coast shipping companies.

When they say that thing, they speak a lie. The administration apparently is to assist the great coal combine of the Atlantic, and the great foreign ship brokers in New York. There can be no other reason, for Pacific coal has sufficient efficiency to be practicable for ordinary use in our naval vessels; it is practicable for use on two Japanese cruisers now in port, these vessels having taken full bunkers of Puget sound coal, and still our navy cannot use it for ordinary cruising purposes, although their boilers are no different that those in a dozen merchant ships regularly using Pacific coast coal. But instead they import Atlantic coast coal at much greater cost to the ships using it, and in addition ruins the trade of our merchant vessels because of the dismissal here of vast foreign tonnage whose expense has been paid to our shores by our government.

It has been reported in the press dispatches that the president has permitted his name to be used as being in favor of assisting our merchant marine, and that prior to the fall election he will speak in public of his views. The president is commander-in-chief of the navy and his principal advisers are those men who are at the head of the navy department, the head of the bureau of equipment, and the chairman of the naval board; those are the men who have chartered the 12 foreign ships referred to in this article, and these are the men who are responsible for having chartered and employed those vessels in defiance of the coasting laws of the country, and consequently annihilates the merchant marine business on this coast, and all of this is done during times of peace, when no emergency exists, and for what? Nothing, except to furnish Atlantic coast coal to our Pacific cruiser fleet, such coal as is not necessary for its ordinary use, a coal that is more efficient than is absolutely necessary for cruising 12 knots per hour; in view of that, what can Mr. Taft say or do which will assist us?—*Railway & Marine News.*

SCHUETTE RECORDING COMPASS.

The Schuette Recording Compass Co., Manitowoc, Wis., has just issued its first booklet descriptive of its new recording compass, which is so constructed as to produce a continuous record of the direction of the ship with relation to time, so that the direction in which the ship was moving at any hour and minute can be determined at a glance at any time thereafter from an inspection of the records produced. These instruments have been fairly tested during the past year aad have given excellent results.

The instrument shows variations of about 2½° (or a trifle less than a quarter of a point), so that if the ship is on her course and the wheelsman lets her go off about 2½° the instrument will immediately register the change of direction and also the exact time this occurred, so that a captain by looking over his chart can tell whether his ship had been working to starboard or to port and whether his instructions had been followed. The chart will also show the conditions of the weather, as in a seaway the records will be very irregular while in smooth weather a comparatively straight line will be produced.

The size of the instrument is 2 ft. square and 10 in. deep and it can be connected to any ordinary socket any place on the ship and any current can be used from 90 to 120 volts; it requires no attention except placing a new chart on the roll every month and filling the pen about every two weeks. The clock movement which moves the chart exactly 2½ in. an hour is wound electrically and requires no attention whatever. One of the special features is the circuit changer which automatically throws the instrument on a set of batteries, if the dynamo current for any reason should give out, and again throws the instru-

ment on the dynamo circuit when the dynamo is again in operation, so that the apparatus is constantly in commission.

The chart will last thirty-one days and the time and date are printed thereon. The time is graduated to five-minute spaces so that it is an easy matter to ascertain the time to less than a minute at a glance. All points east of north and south are shaded while all points west of north and south are clear, so that the chart can be read with comparative ease.

SUMMARY OF NAVAL CONSTRUCTION.

The monthly summary of naval construction, issued by the bureau of construction and repair, shows the following progress upon vessels:

Name of Vessel—	Building at—	—1909— Per cent of completion. May 1.	June 1.
	BATTLESHIPS.		
South Carolina	Wm. Cramp & Sons	90.0	92.3
Michigan	New York S. B. Co	97.4	98.1
Delaware	Newport News S. B. Co	77.9	82.4
North Dakota	Fore River S. B. Co	81.5	84.8
Florida	Navy Yard, New York	11.9	16.4
Utah	New York S. B. Co	14.9	20.0
	TORPEDO BOAT DESTROYERS.		
Smith	Wm. Cramp & Sons	81.6	88.4
Lamson	Wm. Cramp & Sons	75.7	80.5
Preston	New York S. B. Co	70.7	77.4
Flusser	Bath Iron Works	68.7	74.0
Reid	Bath Iron Works	67.8	73.0
Paulding	Bath Iron Works	9.8	14.2
Drayton	Bath Iron Works	9.7	14.2
Roe	Newport News S. B. Co	38.6	46.7
Terry	Newport News S. B. Co	33.7	41.0
Perkins	Fore River S. B. Co	22.0	28.3
Sterrett	Fore River S. B. Co	22.0	28.3
McCall	New York S. B. Co	11.7	13.1
Burrows	New York S. B. Co	11.3	12.8
Warrington	Wm. Cramp & Sons	16.0	19.6
Mayrant	Wm. Cramp & Sons	16.1	23.4
	SUBMARINE TORPEDO BOATS.		
Stingray	Fore River S. B. Co	89.8	91.7
Tarpon	Fore River S. B. Co	89.7	91.7
Bonita	Fore River S. B. Co	81.4	85.2
Snapper	Fore River S. B. Co	80.4	84.9
Narwhal	Fore River S. B. Co	89.7	91.6
Grayling	Fore River S. B. Co	84.6	88.8
Salmon	Fore River S. B. Co	75.3	81.0
Carp	Union Iron Works	0.0	0.0
Barracuda	Union Iron Works	0.0	0.0
Pickerel	The Moran Co	0.0	0.0
Skate	The Moran Co	0.0	0.0
Skipjack	Fore River S. B. Co	0.0	0.0
Sturgeon	Fore River S. B. Co	0.0	0.0
Thrasher	Wm. Cramp & Sons	0.0	0.0
Tuna	Newport News S. B. Co	0.0	0.0
Seal	Newport News S. B. Co	12.7	18.0
	COLLIERS.		
Vestal	Navy Yard, New York	98.6	98.6
Prometheus	Navy Yard, Mare Island	98.9	98.9
	TUG BOATS.		
Patapsco	Navy Yard, Portsmouth	99.0	99.0

SHIP YARD NOTES.

The Fore River Ship Building Co., Quincy, Mass., recently launched the submarine torpedo boats Grayling, Bonita and Snapper. The Bonita and Snapper are duplicates of the Octopus, being 105 ft. long. The Grayling is a duplicate of the Narwhal, 135 ft. long.

The non-magnetic yacht Carnegie was launched from Tebo's Yacht Basin, foot of Twenty-third street, Brooklyn, N. Y., on Saturday, June 12. Not a single iron bolt, spike or nail has been used in building the Carnegie, the hull being held together by locust tree nails and copper bolts and spikes. The engine equipment is of non-magnetic material, the cook ranges are of bronze, the tableware of Mexican silver and the cooking utensils are either copper or aluminum.

Lieut. Col. Graham D. Fitch's report on the proposition for securing increased anchorage area in the vicinity of Superior entry, Duluth-Superior harbor, is unfavorable to the improvement.

Bids received by Lieut. Col. Graham D. Fitch for furnishing riprap at Ashland were as follows: Alex. Sang, Duluth, Minn., Division A, sand stone, granite or trap, $1.05 per ton; Division B, granite or trap, $2.10 per ton; Whitney Bros. Co., Superior, Wis., Division A, $1.20 per ton; Division B, $2.50 per ton. Alex. Sang's bid was accepted.

The new White Star Canadian liner Laurentic, made an excellent showing in her trial tests. The coal consumption per indicated horsepower was as low as 1.1 lb. and only 11 lb. of water per indicated horsepower.

The Newport News Ship Building & Dry Dock Co. has been awarded contracts for four freight steamers for the Morgan line. These steamers are to be 450 ft. long each.

The Wilson Line has given contract to the Harlan & Hollingsworth Corporation, Wilmington, Del., for two steamers 240 ft. long and 40 ft. beam over guards. These vessels will be similar to the Brandywine and City of Chester.

Philip D. Winstanley succeeded the late Henry Wilkinson as chief surveyor for the United States for the Bureau Veritas, International Register of Shipping, 17 State street, New York.

The Craig Ship Building Co., Long Beach, Cal., launched the ocean-going tug Virgil G. Bogue on June 12. The tug is intended for work in the harbor at Long Beach and is 120 ft. over all and 24 ft. beam.

Oliver Reeder & Son, Baltimore, Md., have on the stocks one harbor lighter 92 ft. long by 28 ft. beam by 8 ft. 6 in. deep. They are also rebuilding the schooner Annie Belle, 77 ft. 8 in. long, 23 ft. beam and 5 ft. 7 in. deep.

The new freighters building for the Southern Pacific Co. will be 403 ft. in length from forward side of stem to either side of stern post, 53 ft. beam and 36 ft. deep.

George Lawley & Son Corporation, South Boston, Mass., are about to build a 125-ft. motor launch for C. B. Borland, of Chicago. They also have an order for an 80-ft. launch for a New Yorker and also a small steel launch hull for Messrs. Tams, Lemoine & Crane, of New York.

The Dubuque Boat & Boiler Co., Dubuque, Ia., are building a catamaran ferry for the Burnside & Donaldsonville Packet Co., of Burnside, Ala.

The Submarine Signal Co. has issued a bulletin concerning its service. The total number of vessels equipped with submarine signalling apparatus now is 498.

The G. G. Deering Co., Bath, Me., are building a four-masted schooner to carry about 1,800 tons. She has a southern oak frame, is planked and ceiled with long-leafed yellow pine, and is expected to be launched about Aug. 1. She will cost about $65,000.

The Fore River Shipbuilding Co. is building a freighter for the Union Sulphur Co.; also a yacht 216 ft. over all, for Commodore James of the New York Yacht Club.

The Harlan & Hollingsworth Corporation, Wilmington, Del., are building two freight and passenger steamers to operate between Philadelphia and Wilmington for the Wilson line. They are to be 205 ft. over all, 40 ft. beam over guard, 32 ft. beam molded and 11 ft. 4 in. depth molded.

The Newport News Ship Building & Dry Dock Co., Newport News, Va., have merchant vessels under order or under way as follows:

One freight steamship for A. H. Bull & Co., of New York, 310 ft. by 46 ft. by 24 ft. 3 in.; 1,200 I. H. P.; 2,800 gross tons.

One freight and passenger steamship for the Matson Navigation Co., of San Francisco, Cal., 423 ft. 6 in. by 54 ft. by 33 ft. 6 in.; 5,500 I. H. P.; 6,800 gross tons.

Three oil barges for the Standard Oil Co., of New York, each 225 ft. by 36 ft. by 10 ft.; 700 gross tons each.

Two freight and passenger steamships for the San Francisco & Portland Steamship Co., of San Francisco, 364 ft. by 47 ft. by 34 ft.; 4,000 I. H. P.; 4,100 tons gross.

Two freight and passenger steamships for the Ocean Steamship Co., of Savannah, Ga., 379 ft. by 49 ft. 6 in. by 35 ft.; 2,500 I. H. P.; 5,600 tons gross.

One oil tank steamship for the Associated Oil Co., of San Francisco, Cal., 382 ft. 4 in. by 52 ft. by 30 ft.; 2,000 I. H. P.; 5,200 gross tons.

Four freight steamships for the Southern Pacific Co., 410 ft. by 53 ft. by 36 ft.; 5,500 I. H. P.; 5,700 gross tons.

In addition to the merchant work listed above this company has under construction or under contract three torpedo boat destroyers and one battleship for the United States navy and two submarine torpedo boats for the Lake Torpedo Boat Co., of Bridgeport, Conn.

The Gildersleeve Ship Building Co., Gildersleeve, Conn., has under construction or under order five deck scows 112 ft. by 30 ft. by 10 ft.; seven coal boats 116 ft. by 30 ft. by 12 ft. 6 in., for Louis Gildersleeve, 1 Broadway, New York.

The Coastwise Transportation Co. has given an ordeer to the New York Ship Building Co. for two steel colliers to be 375 ft. long, 49 ft. beam and 30 ft. depth equipped with triple-expansion engines and Scotch boilers. The Coastwise Transportation Co. has hitherto carried its coal in sailing vessels.

The Pusey & Jones Co., Wilmington, Del., have the following boats under construction: One mine planter, 168 ft. long for the United States quartermaster's department; one steel hull double and knock down ferryboat for service in Porto Rico; one steel hull single-screw steam yacht 167 ft. long for William A. Laydon, Chicago; one steel hull, single-screw steam yacht 180 ft. long for George F. Baker Jr., of New York.

The Jackson & Sharp Co., Wilmington, Del., have the following work under way: One sand barge, 116 ft. long by 28 ft. beam and 8 ft. deep; one dump scow; 138 ft. long, 38 ft. beam and 11½ ft. deep; one steam lighter, 110 ft. long, 29½ ft. beam and 9½ ft. deep; one tow boat, 75 ft. long, 18 ft. beam, 9 ft. deep.

Bids for the construction of the two battleships, Arkansas and Wyoming, will be opened by the navy department on Aug. 15. They will be equipped w... turbine engines.

The Pusey & Jones Co., Wilmington, Del., has been given an order by the war department for a steel ferry boat for service in New York harbor on its bid of $88,846.

Cramps, Philadelphia, will build three steel

harbor vessels to cost $236,500 for the quartermaster's department, United States army.

The Skinner Ship Building & Dry Dock Co., Baltimore, has received an order to build a 118-ft. tugboat for the Baltimore & Ohio railroad.

The Maryland Steel Co., Sparrow's Point, Md., launched the collier Hector on July 3, the Mars and Vulcan having previously gone overboard.

SHIP BUILDING ON THE PACIFIC COAST.

Reports from the various ship builders of the Pacific coast received at the Seattle office of THE MARINE REVIEW during the month of June indicate a fair amount of activity, especially in the construction of small steam vessels. Considerable more new work is hoped for in the near future. Conditions in the ship yards are improving steadily, although slowly. Most yards are doing at least 20 per cent better than they were a year ago. The yards of the north coast are more active than those at California ports.

The Union Iron Works Co., San Francisco, reports no vessels under construction and nothing built since Jan. 1, 1909.

The United Engineering Works, San Francisco, writes that it is building the machinery equipment for the steeamer Klamath, the main engines being triple expansion, 15¼-in., 25¾-in., 43¼-in. x 30-in. stroke. The company is also building the engines for the yacht Companero. These are fore-and-aft compound 8 in. by 18 in. by 12 in. stroke. A 62-ft. steel fire boat for the Alaska Packers' Association is being built also a steel supply barge 81 ft. long for the Standard Oil Co. The company also constructed the steel launch Inspector, 70 ft. long by 14 ft. beam, built for the United States government.

The Risdon Iron & Locomotive Works, San Francisco, reports the following new work in the yards: Sister ships David Scannell and Dennis T. Sullivan, steel twin screw fireboats for the city of San Francisco 120 ft. in length over all, 26 ft. molded beam, gross tonnage 250 each.

Joseph Supple, Portland, Ore., has finished the new steamer Hyak since Jan. 1. She is 118 ft. long and 20 ft. beam, built of wood with a double planked hull and equipped with a 750-horsepower Seabury engine.

The Willamette Iron & Steel Works, Portland, Ore., has completed the following work since Jan. 1: H. B. Kennedy, steel passenger steamer 190 ft. in length with 2,000 horsepower four cylinder triple expansion engines; two steel artillery tenders for the U. S. government, each 98 ft. long by 22 ft. beam, fitted with compound engines; engines for stern wheel river steamer Inland Empire. This company has recently received a contract for the machinery for the new 150-ft. Coeur d'Alene lake steamer Harrison.

The Moran Co., Seattle, reports the following work in progress: One single screw steel freighter, 240 ft. in length and 41 ft. beam, triple-expansion engines, 17 in., 28 in., 47½ in. diameter by 36 in. stroke. Also two steel submarine torpedo boats for the U. S. government. This company has also built two stern wheel river steamers for Alaska service since Jan. 1.

Kruse & Banks' Ship Building Co., North Bend, Ore., have completed two car floats for the Western Pacific railway. Each float is 272 ft. in length by 40 ft. beam and 12½ ft. deep.

Hall Brothers Marine Railway & Ship Building Co., Winslow, Wash., have completed two car floats for the C. M. & St. P. Ry., each float being built of wood. The dimensions of the floats are: Length, 191 ft.; beam, 42 ft. and depth, 11 ft.; tonnage, 630 gross and net. The company has also rebuilt the old steamer Victorian.

Philip D. Sloan, Seattle, has built the wooden passenger steamer Vashonian. The Vashonian is 125 ft. in length and 234 gross tons register, fitted with a 650-horsepower triple-expansion engine built by the Northwestern Iron Works, Seattle, Wash. Mr. Sloan also rebuilt the old steamer Vashon, since renamed Wireless.

Crawford & Reid, Tacoma, Wash., have built the steamer Daring, 110 ft. in length by 19 ft. beam., fitted with a 475-horsepower engine built by A. F. Hutton, Seattle.

Puget Sound Ship Building Co., Richmond Beach, Wash., is building the new steel fireboat for the city of Seattle. The machinery for the fireboat is being built by the Fulton Machine Works, Seattle.

O. R. & N. BUILDING LAKE STEAMER.

The Oregon Railway & Navigation Co., part of the Harriman system, is building a new stern wheel steamer for fast passenger service on Lake Coeur d'Alene, Idaho. The new steamer will be named Harrison and will operate between Harrison, Idaho, and a point on the west side of the lake at the terminus of a new O. R. & N. branch from Spokane. By using the steamer in this manner the long detour around the south end of the lake is avoided and the running time between Spokane and the Coeur d'Alene mining district will be cut 3½ hours.

The machinery for the new steamer, which is being built by the Willamette Iron & Steel Works, Portland, Ore., consists of a pair of long-stroke stern-wheel engines, 13 in. in diameter by 72 in. stroke, working under 225 lb. per square inch boiler pressure. The boiler will be of the locomotive firebox type working under a pressure of 225 lb. The machinery will be delivered about Aug. 20 and the boat will be put in service about Sept. 15, 1909.

PEARL HARBOR DRY DOCK.

Bids for the construction of the dry dock at the Pearl Harbor naval station, Hawaii, were received by the navy department as follows: C. M. Leach, P. O. box 2285, Boston, Mass., $1,295,321 on item No. 1; San Francisco Bridge Co., 681 Market street, San Francisco, $1,760,000; Edward Malley, 1384 McAllister street, San Francisco, $1,800,000; E. J. Lord, Honolulu, T. H., $1,792,000; Pacific Construction Co., 16 California street, San Francisco, $1,779,440; McArthur Bros. Co., 11 Pine street, New York, $1,905,000; W. N. Concahon Co., 433 onadnock building, San Francisco, $1,930,000; Cotton Bros. & Co., 241 Bacon building, Oakland, Cal., $1,961,284; H. E. Talbott Co., Reibold building, Dayton, O., $2,164,522; S. Pearson & Son, Long Island City, $1,941,300. Contract was awarded to the San Francisco Bridge Co.

LAKE ORE SHIPMENTS.

The figures for the June movement of ore show with what ease the ore trade of the lakes is handled in spite of strikes and other impediments. It also proves pretty conclusively that some of the smaller steel freighters will have to seek other employment. There is no room for them in the ore trade. The vessels moved 5,393,255 tons in June with probably not more than 60 per cent of the fleet in commission. To July 1 the fleet has moved 8,702,323 tons. While this is an increase of 5,831,326 tons over the corresponding period last year it is a decrease of 3,983,307 tons when compared with the corresponding period for 1907. However, everyone expects an easy movement from now on and it will be no trouble whatever for the vessels to overcome the handicap of a bad start. Following are the ore figures:

	June, 1907.	June, 1908.	June, 1909.
Escanaba	809,876	254,496	747,377
Marquette	392,186	119,014	287,127
Ashland	554,168	250,449	371,169
Superior	1,217,729	345,845	856,062
Duluth	2,156,216	1,078,118	1,968,800
Two Harbors...	1,303,194	537,760	1,162,720
Total	6,433,369	2,585,682	5,393,255

	To July 1, 1907.	To July 1, 1908.	To July 1, 1909.
Escanaba	1,824,215	260,741	1,132,233
Marquette	769,059	119,014	420,224
Ashland	1,049,357	271,577	612,024
Superior	2,318,911	478,633	1,464,577
Duluth	4,094,046	1,164,809	3,184,725
Two Harbors...	2,630,036	566,193	1,888,540
Total	12,685,630	2,870,997	8,702,323

Increase of 1909 over 1908, 5,831,326.

HYDROGRAPHIC OFFICE INFORMATION.

The hydrographic office receives many letters seeking information and as the replies thereto are equally interesting to the general reader as to the inquirer the office will hereafter incorporate the replies in its pilot chart of the North Atlantic ocean. For instance the following is clipped from the July chart:

"We have had a discussion about the greatest depth of the sea. One authority states that the greatest depth yet found is 31,614 ft., near the Island of Guam. Please let me know if this depth is correct, and if this is still considered the greatest depth."

Answer.—The greatest ocean depth known is 5,269 fathoms or 31,614 ft. It is in latitude 12 deg. 43 min. 15 sec. N., longitude 145 deg. 49 min. E., about 75 miles ESE. of the Island of Guam. This depth was obtained Nov. 14, 1899, by the U. S. S. Nero, when running a line of soundings to locate the Honolulu-Midway-Guam-Manila cable.

SHOAL SPOTS OFF CHICAGO HARBOR.

The United States lake survey steamer Search, which is engaged in sweeping the lake front off Chicago, reports the following menaces to navigation:

1. A mud dump showing at present stage a least depth of 12 ft., Azimuth 116 deg. (S. 64 deg. E.) and distant 2,150 ft. from rear light of pierhead range, Chicago harbor.

2. A mound of rock and gravel, about 2,000 ft. long north and south, and having a width of 600 ft., with least depth of 19¼ ft., lying Azimuth 269 deg. (S. 89 deg. W.) and 12,300 ft. distant from the four-mile crib.

3. A small mound of rock with least depth of 22 ft., Azimuth 265 deg. (S. 85 deg. W.) and 9,150 ft. distant from the four-mile crib.

4. A pile of rock with least depth of 18½ ft. marked by white spar buoy. This lies Azimuth 266 deg. (S. 86 deg. W.) and distant 8,100 ft. from four-mile crib.

5. A wreck or snag showing least depth of 24 ft., lying in 36 ft. of water. This is Azimuth 245 deg. (S. 65 deg. W.) and distant 3,300 ft. from four-mile crib.

SAULT STE. MARIE CANAL REPORT.

During June 6,932,405 net tons of freight were moved through the canals at Sault Ste. Marie, making the total movement to July 1, 12,117,367 tons, an increase over the movement of 1908 of 6,115,042 tons, but a decrease over the movement of 1907 of 5,670,952 tons. Following is the tabulated statement to July 1 of the present year, with corresponding data for the two preceding years:

EAST BOUND.

	To July 1, 1908.	To July 1, 1909.
Copper, net tons........	27,484	34,731
Grain, except wheat, bu..	7,293,272	9,182,563
Building stone	....	880
Flour, bbl.	1,179,406	1,691,948
Iron ore, net tons......	2,733,430	8,073,482
Pig iron, net tons	4,364	7,290
Lumber, M. ft. B. M...	112,227	145,245
Wheat, bu.	22,442,683	19,002,817
Unclassified freight, tons	20,583	48,149
Passengers, number	4,052	4,767

WEST BOUND.

Coal, hard, net tons....	364,914	448,397
Coal, soft, net tons.....	1,396,961	1,893,135
Flour, bbl.	....	1,320
Grain, bu.	700	500
Manufactured iron, tons.	82,602	120,835
Iron ore, tons	....	3,474
Salt, bbl.	199,915	243,379
Unclassified freight, tons.	190,592	280,381
Passengers, number	4,809	4,820

SUMMARY OF TOTAL MOVEMENT.

East bound, tons........	3,937,509	9,334,789
West bound, tons	2,064,816	2,782,578
Total	6,002,325	12,117,367

AROUND THE GREAT LAKES.

The United States revenue cutter Fessenden, which was purchased by George L. Craig, of Toledo has been remodeled to operate between Cheboygan, Mackinac island and Sault Ste. Marie. She has been renamed the Chippewa.

Capt. Henry L. Foster died at Painesville, July 6, at the age of 77 years. He formerly sailed the Garden City.

The steamer G. A. Tomlinson, which is building at the Lorain yard of the American Ship Building Co., for Capt. J. J. H. Brown, of Buffalo, will be launched on Saturday, July 10.

The Buffalo Dredging Co. has sold its drill boat No. 4 to the Standard Construction Co., of Cleveland.

The bulk freighter building at Lorain for Mr. A. T. Kinney, will be named in honor of Mr. J. S. Ashley, of the firm of M. A. Hanna & Co.

The bulk freighter, John Sherwin, went ashore in Buffalo harbor near the south gap on July 4. She was released after 500 tons of ore had been lightered.

The Great Lakes Dredge & Dock Co. is deepening the river at Lorain near the Nickel Plate bridge.

Capt. Thomas M. Hough, master of the Rutland Transit Co. steamer, Ogdensburg, died at Chicago on July 3 at the age of 45 years.

The schooner Melbourne, which was tied up at the Ellsworth dock at the outer harbor at Cleveland, was pounded in the storm of July 2, so that she sank at the dock, blocking the channel. She is owned by Richard Burns, of Detroit.

Mr. James C. Wallace, president of the American Ship Building Co., who is gradually recovering from an attack of typhoid fever, left for the east early in July to spend the remainder of the summer.

Mr. Robert Wallace, of the American Ship Building Co., has gone to Ireland.

The lumber steamer, Tempest No. 2, burned and sank at Parry Sound, during the latter part of June. She was owned by Capt. E. J. Eber and Seymour Ward, of Tonawanda.

The new steamer, Isaac M. Scott, which left Lorain on her maiden trip on July 2, is being sailed by Capt. A. McArthur.

The schooner John Schuette, bound up with coal, was struck by the steamer Alfred Mitchell in the lower Detroit river July 2 and sunk. She became unmanageable in a gust of wind and the Mitchell was unable to avoid her.

The Clarkson Coal & Dock Co., of St. Paul, has leased the Pioneer dock on Rice's point, Duluth, from the Pittsburg Coal Co.

While entering the harbor of Toronto the steamer H. M. Pellatt, of the Canadian Lake & Ocean Navigation Co. fleet, ran into the ferry steamer, John Hanlan, and sank her.

The four Hulett machines at the docks of the National Tube Co., at Lorain, took out 9,512 tons of ore from the steamer Ward Ames in five hours, eight minutes, on July 1. Mr. Robert Aspin, superintendent of the dock, believes this to be the record for four machines.

The Anchor Line announces the appointment of M. S. Mead, of Erie, as agent at Duluth. He succeeds the late D. A. Christy. W. W. Farley becomes agent at Erie.

Peter Paul Miller, for many years identified with vessel interests, died at Buffalo on June 24. He began as assistant engineer of the steamer Mohawk, of the Western Transit Co.'s fleet, later becoming a director of the line. He was also financially interested in the Red Star Line.

The new public dock at Erie, Pa., was dedicated on June 24 with elaborate ceremonies, participated in by Gov. Edwin S. Stuart and Lieut. Gov. Robert S. Murphy.

The package freighter, Conemaugh, building for the Anchor Line at the Wyandotte yard of the American Ship Building Co., was launched on June 24, being christened by Mrs. J. C. Evans. The Conemaugh is 372 ft. over all, 350 ft. keel, 46 ft. beam and 30 ft. deep, equipped with quadruple-expansion engines with cylinders 19, 27½, 40 and 58 in. diameters, supplied with steam from two Scotch boilers 11 ft. 6 in. long by 11 ft. 6 in. diameter.

Laird & Sons, Ashtabula, launched the tug Margaret Dahlmer for Capt. John Dahlmer, of Dunkirk, on June 23. The tug is 70 ft. over all, 15 ft. beam and draws 7 ft. 6 in.

George E. Pierce, general manager of the Wheeler and Monarch elevators, and formerly in charge of the Kellogg elevator, has purchased the Evans grain elevator.

The Pittsburg Steamship Co., through President Harry Coulby, has given a contract to the American Ship Building Co. for two bulk freighters to be duplicates of the A. C. Dinkey and Eugene J. Buffington. They will be 600 ft. over all, 580 ft. keel, 58 ft. beam and 32 ft. deep. This makes 12 600-footers that the Pittsburg Steamship Co. has built in the past four years, and 16 vessels altogether of over 10,000 tons carrying capacity.

The steamer William P. Thew was sunk off Thunder Bay island in collision with the steamer William Livingstone, during a heavy fog.

During the past month the vessels of Boland & Cornelius, of Buffalo, and M. A. Bradley, of Cleveland, were enrolled in the Lake Carriers' Association.

YEAR'S SHIP BUILDING.

The bureau of navigation reports 1,072 sail and steam vessels of 171,864 gross tons built in the United States and officially numbered during the year ended June 30, 1909, as follows:

	WOOD.				STEEL.					
	Sail.		Steam.		Sail.		Steam.		TOTAL.	
	No.	Gross.	No.	Gross.	No.	Gross.	No.	Gross.	No.	Gross.
Atlantic and Gulf	108	18,835	395	9,781	8	7,472	23	28,613	534	64,701
Porto Rico	7	79							7	79
Pacific	17	287	204	11,533			1	499	222	12,319
Great Lakes			99	1,644	1	513	36	88,426	135	90,583
Western Rivers			167	3,762			6	420	173	4,182
Total	132	19,201	865	26,720	9	7,985	66	117,958	1,072	171,864

During the corresponding year ended June 30, 1908, 1,151 sail and steam vessels of 500,327 gross tons were built in the United States and officially numbered, as follows:

	WOOD.				STEEL.					
	Sail.		Steam.		Sail.		Steam.		TOTAL.	
	No.	Gross.	No.	Gross.	No.	Gross.	No.	Gross.	No.	Gross.
Atlantic and Gulf	108	32,667	328	12,792	1	63	52	87,311	489	132,833
Porto Rico	5	83	1	11					9	94
Pacific	15	3,034	266	25,958			11	24,850	292	55,842
Hawaii			1	14					1	14
Great Lakes	4	52	86	3,193			75	304,379	165	307,024
Western Rivers			192	5,356			3	564	195	5,920
Total	135	35,836	874	47,324	1	63	141	417,104	1,151	500,327

COMPARATIVE STATEMENT.

1909.	No.	Tons.	1908.	No.	Tons.
Sail and Steam	1,072	171,864	Sail and Steam	1,151	500,327
Unrigged	290	60,952	Unrigged	355	88,300
Total	1,362	232,816	Total	1,506	588,627

The American Ship Building Co. has sold the steamer A. S. Upson to A. T. Kinney, of Cleveland. The Upson was launched last March.

The steamer Isaac M. Scott, building for the Virginia Steamship Co., was launched from the Lorain yard of the American Ship Building Co., June 12. The Scott will be managed by M. A. Hanna & Co. She is in the 524 ft. class.

PERSONAL.

Mr. Vernon H. Brown, agent of the Cunard Line for many years at the port of New York, has been appointed an American trustee of the Royal Exchange Assurance of London. Mr. Brown will retire from active service in the Cunard Line Aug. 1.

Walter H. Millard, who has been a draftsman and designer in his brother's office for the past eight years, has been made a partner in the business. The firm hereafter will be known as W. J. Millard & Bro., with offices at 17 State street, New York.

John A. Stevens, member of the American Society of Naval Architects and Marine Engineers, announces that he has opened an office as consulting engineer at 107 Merrimack street, Lowell, Mass.

TRANSMISSIONS AND THEIR LUBRICATION.

In many plants of our various industries, especially in those of the smaller ones, are found installations that have long outlived their usefulness, or have become out-of-date and have not been rebuilt, partly due to the fear of excessive cost or a possible "shut" down.

An example of neglect, especially in the smaller or older mills, is in their shafting, the initial installation of which did not permit a large expenditure for the entire development and in many instances was planned and erected by inexperienced parties.

If the reconstruction should be found too expensive or possibly inexpedient, the manufacturer should adopt a method to at least utilize his power efficiently. In what simpler way can this be accomplished than in the selection of an efficient lubricant?

Waste is most noticeable on line shafting but the usual friction loss would be materially reduced by the use of an efficient lubricant, such as Albany Grease, which combines in itself the best lubricating element of the best oil and tallows with the tenacity and viscosity to insure the lasting and cooling properties without waste. This efficiency in lubrication reduces friction to a minimum, which in turn increases the power transmitted.

In many plants the bearings are lubricated with sight feed oilers and barrel after barrel of oil is thoughtlessly put into the bearings of which at least half is lost, by dripping to the floor or along the bearing supports, the appearance of which is decidedly unclean to say nothing of the consequent fire risk and expenditure necessary in the course of a year for constant attention and attendance. When later a hot-box is discovered, which under these conditions is unavoidable, the expense may eventually be a heavy one.

It might be suggested that the installation of mechanical oiling devices would eliminate this annoyance, but they are apt to get out of order and fail at a critical time. The engineer is also here dependent upon the reliability of the oil used. He cannot have every barrel of oil examined by a chemist, and even if he is familiar with its analysis he will still be more or less at sea in regard to its action, as his time is too limited to make extensive tests and take the necessary observation himself.

It is evident that the perfect lubricant required is one, the consistency of which must adjust itself with its fluidity and thereby have a capacity for storing and carrying away heat, in other words must have the property of keeping a bearing cool. This can only be accomplished with a neutral grease of uniform quality, having comparatively low melting points, so that it will melt readily and thus lubricate, cool and preserve the bearing. Such a lubricant is found in "Albany Grease," which has been on the market and in extensive use for over 40 years, and is claimed to be the ideal or perfect lubricant.

The success of Albany Grease, it may be stated, is based upon merit. When properly applied it meets every requirement of the ideal lubricant and the old saying is found to be a true one, i. e., "Grease is cheaper than machinery."

When spindle cups are used the consumption is extraordinarily small and the slight changes in its adaptation will be more than paid for within a reasonable time.